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Reclamation for Victory

(Gas furnaces at Westinghouse Linhart Works reclaim 20 tons of scrap metal daily.)

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GEORGE A. STETSON, *Editor*

Civics for Engineering Students

FOR several years The American Society of Mechanical Engineers has maintained a Committee on Engineers' Civic Responsibilities, of which A. R. Cullimore, president of Newark College of Engineering, is the chairman. It has been one of the objectives of this committee to interest students of engineering in civic matters and the responsibilities of citizenship. Dr. Cullimore, who has made these subjects matters of personal interest in his own institution, has done much to advance a worthy cause and in this he has been ably assisted over a period of years by Roy V. Wright, past-president of the A.S.M.E., whose long activities in good government and public posts in his own community have given him first-hand knowledge of civic duties and practical politics. Mr. Wright's lectures, and particularly the discussion periods which have followed them at Newark, have given hundreds of students a comprehensive picture of what the good citizen ought to know and do. Early in January Mr. Wright assumed office in the legislature of New Jersey as state senator from Essex County, thus affording one more striking illustration of the effectiveness of an engineer in public affairs.

In the A.S.M.E. News section of this issue will be found a report of the committee headed by Mr. Cullimore. In it is mentioned a means, recently adopted by the committee and made possible by the generosity of its friends, whereby further interest in its work is aroused at Newark, Stevens, and Purdue. Prizes are being awarded at these institutions for biographical essays of engineers prominent in the public service. Mr. Wright himself served as the subject of the first of these essays. The sketch, written by a student at Newark, class of 1941, is also published in connection with the report to arouse interest in this practical demonstration of one of the committee's methods of interesting students, in the hope that other schools may find it of practical value.

New Heat-Transfer Research Tool

HEAT-transmission problems are so common, so important, and in many cases so baffling that any improvement in technique that cuts down the time element, the cost, and the limits of accuracy is a significant forward step. Such a technique has been developed recently and is described in a paper, "A Method for Determining Unsteady-State Heat Transfer by Means of an Electrical Analogy," by Victor Paschkis and H. D. Baker in the February, 1942, issue of the A.S.M.E. Transactions. A simple example will serve to illustrate the value of the new method.

For years experimental means of determining the loss of heat through building materials has involved construction of a model made of these materials and large enough to avoid influence of shape factor. With this model are arranged a source of measurable heat energy and essential thermometers or thermocouples, and a procedure is followed which necessitates a long period for bringing the apparatus to a state of uniform heat-flow conditions. This generally requires waiting for a favorable combination of outside temperature, wind velocity and direction, and other influencing factors, all of which may change disturbingly during the course of the experiment. Days and weeks may elapse between starting construction of the model and satisfactory completion of the experiment and recording of the data. Using the electrical model constructed by Dr. Paschkis, the essential heat-transfer data of such a problem can be determined and recorded in less than an hour after the apparatus has been set up. The effect of a different external condition, say, the increase of wind velocity on the exposed surface, can be recorded in another quarter hour, and the doubling of the wall thickness, or some substitution of structural material, can be investigated in 15 minutes more. No building material need be purchased, no wall section constructed, no time is lost waiting for the model to assume uniform conditions or for the outside temperature or wind velocity to reach predetermined values. Within a few hours the same apparatus can be arranged to record the temperature gradients of a cooling ingot of steel, into which it would be impossible to insert the thermocouples for thermal measurement of changing conditions, or it may be adjusted in an equally short space of time and without expenditures for special measuring devices for studying the temperature-time pattern of a brick kiln or a heat-treating furnace.

Engineers can determine the clearances of a steam-turbine rotor in its casing when both are cold and when both have assumed normal operating temperature. But what happens during the warming-up process when rotor, casing, and blades are undergoing expansion at different rates? Dr. Paschkis says he can arrange his electrical model to discover these time-temperature gradients without moving out of his Columbia laboratory.

Or suppose someone wanted to know the quick-freezing characteristics of turkeys, or the baking characteristics of bread, or the time-temperature changes of soil, or of an automobile clutch, or of the brake shoes of a high-speed train, or at the point of a tool cutting metal, or the change in capacity of an electrical cable under a fluctuat-

ing load, or the temperature characteristics of plastics or glass or a tire vulcanizer. The same apparatus and the same technique used in the simple problems of steady-state flow through building material or pipe insulation, which have been tackled by thermal methods dozens of times but which are intricate, baffling, and even impossible when unsteady-state heat flow is involved, are employed. The data are quickly and accurately found and recorded. Hours of slow thermal changes are compressed into seconds. Or, the almost instantaneous temperature changes taking place in an internal-combustion-engine cylinder, for example, are lengthened at will. Time-temperature curves are automatically drawn, and either scale can be compressed or extended as desired.

Dr. Paschkis' method, which is based on the mathematical similarity of certain thermal and electrical phenomena, was originally published by Dr. C. L. Beuken, of the Netherlands. Dr. Paschkis worked with Dr. Beuken in Europe and brought the method to this country where he has considerably improved it. The method is simple and accurate because it substitutes electrical measurements, which are easily made, for thermal measurements, which are difficult, cumbersome, inaccurate, and in many cases impossible to make. It involves, of course, knowledge of temperatures and the thermal properties of the substances through which the heat is to flow. This latter requirement may involve difficulties in some cases, too common because of the inadequacy of our thermal data and the expense and skill required for making heat-capacity determinations, but well known in the case of many common substances. Yet even here the method, used backward as it were, has potentialities. Because of the nature of the technique and the mathematical relationships existing among the variables and constants involved, an experiment, carried out for conditions in which a substance of known heat capacity is used, can be repeated for conditions in which the substance of unknown heat capacity has been substituted. The unknown heat capacity then becomes known because the change in the electrical setup that had to be made to reproduce all other conditions can be translated into the heat capacity sought.

Today, when time and knowledge are vital to the winning of the war, this new method should put American engineers at a decided advantage. When victory is won and the world returns to the keen competition of peace, this advantage will be none the less potent.

L. P. Alford

THE death of L. P. Alford within a month of his having received the certificate of honorary membership in The American Society of Mechanical Engineers removes from our midst a man who made conspicuous contributions to the wide dissemination of the principles of industrial management. As editor, author, and more recently as a professor at New York University, he brought to a large group of engineers not only interpretations of the work of men like Taylor, Gantt, and Gilbreth, but also a better understanding of how the principles these men formulated and practiced could be adopted in the everyday work of men whose responsibilities ranged all the way from minor supervisory positions to the highest managerial and administrative posts. Nor was his work confined to interpretation only. His own contributions to the increasingly important field of industrial economics, particularly in the gathering and studying of statistical data, showed how properly qualified engineers might bridge the gap between technology and business affairs and interrelate the two. He pioneered in the field of handbooks on management and so-called "laws of management," and was called upon for such important studies as those which formed the basis for the late American Engineering Council's reports on waste in industry, the twelve-hour shift in industry, safety and production in industry, and technical changes in industry, this last being incorporated by the National Bureau of Economic Research in its significant two-volume report, "Recent Economic Changes." The subject matter of his writings, which reflected interests that engaged him from time to time, included among others, bearings and lubrication, artillery and artillery ammunition, development of high-speed drilling machines, industrial relations, preferred numbers, the evaluation of manufacturing operations (in which the unit "kilo-man-hour" was suggested), production control, and management's responsibility for industrial accidents.

Mr. Alford possessed the industrious and solid virtues of his New England background. His customary modest manner and softly spoken voice accentuated the sincerity and logic of clear thinking, lucidly expressed. The orderliness of his mind was fertile ground for the principles of management which he unearthed, studied, practiced, formulated, and taught. His fair, benevolent, and bespectacled countenance is best remembered as being lightened with an infectious and disarming smile, but he made no compromise with truth or conviction. He spoke forcefully and lucidly with an economy of words and an abundance of sound sense and wrote in like manner. When mechanical engineers, facing the cruel reality of disturbed economic conditions in the depression of the thirties, attempted to analyze the situation and offer cures and formulas, it was his own clear analysis that classified their suggestions, pointed out their fallacies, and winnowed the grain of truth from the overwhelming chaff of error.

Industrial management has been given to the world largely through papers and studies sponsored by A.S.M.E. members. In 1922 Alford prepared the first ten-year progress report of the A.S.M.E. Management Division. In 1932 when the second ten-year progress report was published Alford said that it was his ambition to live to prepare the third. His work was cut off before this ambition was realized. But quickly and unexpectedly as the end came, it found his immediate tasks in order. The remaining lectures of his course at N.Y.U. were written. The rest he had planned to take at doctor's orders would have commenced in a few weeks and his assignments had been arranged in anticipation—the true practitioner of the principles he preached to the very end.

PLANNING WILL WIN *the* PEACE

By DAL HITCHCOCK

CHIEF, POSTWAR DIVISION, BUREAU OF LABOR STATISTICS

THE winning of this war is going to be a back-breaking, soul-searing job. As a nation, only this week have we been forced to a realization of what lies ahead. The bombing of American cities, the sinking of American ships, and the killing of American civilian and military personnel have wiped out the last vestige of our reluctance to enter the active conflict against forces that would destroy democracy and everything on which the American way of life is built. The effort now will truly be an "all-out" endeavor. As Senator Wheeler has said, "We'll give them hell!"

With America only started on her war effort, one might question the wisdom of suggesting that some of us turn our minds to postwar problems. Had this war come upon us after a decade such as that between 1900 and 1910 during which "God reigned in his Heaven and all was right with the world," we should be giving little thought to postwar economic problems. There would be no question in the minds of most of us about the kind of peace that lies ahead after military victory has been achieved.

The major postwar problems discussed during World War I centered on plans for international political organization to outlaw war. That era's innocence of impending economic disorder produced the war-breeding Treaty of Versailles and a League of Nations built on untenable foundations. The discussions of economic problems during 1914–1918 were confined largely to trade-union circles on one hand and to revolutionary groups on the other. The trade-union discussions led to the formation of the International Labor Organization and to the enactment of such social legislation as unemployment compensation and other laws affecting individual economic security. The revolutionists overturned Russia and generated a series of upsets throughout the world. But in retrospect it is clear that the revolutions were more important politically than economically.

Nevertheless, the revolutions were real and represented the first threat to the established order that had seemed so secure and so satisfactory in 1910. Then came the depression of 1921 and 1922. The clouds cleared, but only for seven short years. Finally came the staggering blow—1929. For ten years, until 1939, the entire world order was rocked to its very foundations and at last plunged into war. It is not to be wondered that during World War II thinking citizens of all nations have no complacency about the years that will follow the peace. We must have postwar thinking and planning, for out of analysis and understanding will grow our confidence that the future can be gloriously worth fighting for; and out of our confidence in the future will come the will for victory that can give our effort its full strength and make the outcome decisive.

Already the war has demonstrated the truth of a proposition that was fundamental to the economic controversy of the 1930's. In Germany and in England public expenditures have wiped out unemployment. The United States at war, likewise, no longer can afford involuntary idleness of her workers. Every able-bodied man and woman must be put to work, quickly.

We now know, once and for all, that public spending can wipe out unemployment. With that fact demonstrated, the focus of economic discussion is shifting. No longer is there the question: Can we have full employment? For the duration of the war we must and will have full employment, with some 20 to 25 million workmen and members of the armed forces directly engaged as a result of public expenditures. In the postwar world the question will be: How many of the 25 million will look to government for continuing jobs and how many will find peacetime employment in private enterprise? Never again will millions go to the bread lines and relief rolls. Whether government will have to provide jobs for 25 million or 3 million will be determined largely by business rather than by government, but government can help to make it 3 million. If we are to preserve the way of life for which we fight, we must see to it that public policy and business policy are directed to that end.

In the thinking that is being done about the postwar period, two most encouraging factors are present. First, government is beginning to search for the means of helping business rather than for ways of controlling it. The second factor, and perhaps the more important one, is that some business leaders have abandoned the old tune of "do nothing and everything will be all right." They are beginning to look upon and to work at the job of planning for postwar prosperity as businessmen tackle any other business job.

Business is coming to understand the economic responsibilities that government must assume. Government is coming to see that without a vigorous private economy its task would be so large as to imply a fundamental change in our economic institutions. It is not change but the perfection of our institutions for which we fight. The role of business is to conduct the nation's economic activity. The role of government is to manage the elements of our economic environment—we might say, air-condition the economic environment—so that vigorous private enterprise can flourish.

The significance of today's constructive frame of mind in both government and business must not be neglected. It has emerged after ten years of tragic confusion. Perhaps we can see our problems more clearly in the face of a threat to our very existence. The clearer understanding of our economic problems is producing a clearer understanding of the institution of business enterprise. And it is producing a return of self-confidence to businessmen themselves.

In 1929 the leaders of America were plunged headlong into unforeseen catastrophe. The ensuing years were bewildering and they were embittering. The leaders were confused; the public, embittered. For the first time in our national history we turned to our government and demanded that it become paternalistic, that it protect us from "the slings and arrows of outrageous fortune." In all those ten years no dominant voice of business arose to say with calm authority that we have encountered a new set of conditions that need only to be understood to be dealt with. The dominant voices of business said, "Nothing has changed," and businessmen whimpered, "Let us alone, if we do nothing the golden days will return."

America didn't buy that bill of goods. A negative attitude never sold America anything. America never has wanted to return to any era of the past. America believes in her well-tried institutions of democracy and free business enterprise with which she strives and will continue to strive to provide political freedom and economic opportunity for all. She will

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follow the renewed leadership of businessmen who have the strength and courage to blaze the way toward the conquest of insecurity and the eradication of want after our military leaders have won the war.

While the dominant note sounded by representatives of business was complaining and weak during the 1930's, not all businessmen by any means had lost the courage needed for leadership. During the depressed 1930's the businessmen who manufactured electrical household appliances decided that despite "government interference" they could produce and sell more appliances than ever before had been produced and sold in the United States. Their sales reached a peak of $112 million as compared with $84 million in 1929.

Businessmen who produced refrigerators decided that more refrigerators could be sold, if they were produced, than America had ever before bought. Peak sales of mechanical refrigerators reached $364 million as compared with $162 million in 1929. Gasoline producers decided that Americans would burn more gasoline than they ever had used before, and peak production reached 24 billion gallons per year as compared with 18 billion gallons in 1929.

We could go down a list of products which reached their peak sales after 1929. In each case the businessmen who planned the production of these items disagreed with the dominant voice of business spokesmen and decided that no matter how annoying public policies might be, no matter how shaken was general business confidence, business was good enough for their industries to surpass all previous peaks. While some businessmen stood at the wailing wall, others were carrying on the American tradition.

It has occurred to you that I have cited exceptional cases, many of them new industries that were on their initial upswings between 1929 and 1939. This is quite true, but beside the point. In each case some businessman, or group of businessmen, decided that conditions were good enough for expansion and profits. While these new industries were growing, the markets for even our older industries were expanding as a function of population growth and of increased industrial productivity, which is constantly increasing the potential of our per-capita income. Look for a moment at the over-all picture. Between 1930 and 1940 our population increased by nearly 9 millions, or more than 7 per cent. In 1929 our gross national output, which means the production of all consumers goods and services as well as the creation of all new and replacement capital, amounted to only $93.6 billion. The best estimates available today—and they have been carefully checked by one of your outstanding local companies, General Electric—indicate that with our increased population and our improved productivity our gross national productive capacity has expanded by at least 30 per cent since 1929. This means that if Americans were to spend as much of their incomes for railroad travel in the years following the war as they did in 1929, passenger revenues would expand from $873 million to $1135 million. Even with competition from air lines and motorbusses this does not seem to indicate that markets for railroad passenger service are exhausted. In 1929 Americans bought 363 million pairs of shoes from another mundane "mature" industry. A 30 per cent expansion in the sales of shoes as compared with 1929 would mean 109 million additional pairs, a rather nice piece of shoe business. In 1929 Americans produced 627 million light bulbs. A 30 per cent expansion implies that 815 million bulbs would be produced, again a comfortable increase in business.

To illustrate the point the expansion of sales of each item has been indicated in direct ratio with a 30 per cent increase in annual gross national product. This, of course, is an oversimplification. Railroad revenue passenger mileage may increase by less than the average of all goods and services. Sales of shoes and light bulbs may increase by more than 30 per cent. The appraisal of the outlook for each industry is a part of the job of postwar planning to which we shall return shortly.

The point at the moment is that at the frightful cost of learning the lesson through war it is being proved that this 30 per cent expansion of American production and national income is no mere theory. By the end of 1942 it will be an accomplished fact. The problem of the postwar period will not be that of stepping America up to a national output of $110 billion. The war will carry us that high. The problem will be that of *maintaining* an output of $110 billion a year while we convert our operations to production of peacetime goods and services. It will be accomplished only through planning—not planning by government economists sitting at their desks in Washington—but by planning on the part of engineers and businessmen throughout the country. The job couldn't be done in Washington. It can be done only by you men of business who can focus on specific operations, plants, and industries.

If you men and your associates plan to keep America rolling at the rate of $110 billion a year we shall move from war into prosperity. The 55 million people who will be at work in America at the end of this war will find peacetime jobs. With an expansion of its markets of 30 per cent as compared with 1929, American industry should be able to make a profit.

On the other hand, if you men and your associates in business were not to plan to keep America rolling we would go into a tailspin that would make 1929 look like a Sunday-school picnic. If that happens, or even starts to happen, government will have to step into the picture. There is little doubt that the 20 or 25 million people who would become unemployed would rise and say, "We had jobs to produce for war, we demand jobs now that the war is won." If 25 million people demand anything they will get it. If they turn away from business and toward government the leadership of private enterprise will be lost and in all probability our democratic institutions will be ground under the heel of some demagogue who will promise that he can provide jobs for everyone. Hitler made such a promise in 1932.

If the postwar planning must be done by men in industry and in business, why is government interested? I said at the outset that there is a change of emphasis in Washington, a clearer understanding of economic problems. More and more people in Washington are searching for the ways in which the federal government can help business rather than regulate it. Representatives of government such as myself are out over the country talking with groups of businessmen and with representatives of organized labor for two purposes. First, we want to toss the job into your laps. Second, we want you to tell us what the federal government can do to help you.

There are certain obvious studies that can be made at the level of the federal government that should provide useful information to many industries. I shall sketch briefly the things that have been undertaken in Washington as the first steps in the government's postwar studies. One project has been to assemble what we may call a statistical description of the size, character, and geographical distribution of each major national industry. We are developing an encyclopedic file that tells us where the plants of each industry are located, the employment in each of these plants, what has happened to the industry under the influence of the war program, and what future war production schedules imply for each industry. From the industrial point of view these facts and figures define the magnitude, location, and character of the adjustment that will take place as industry swings back to civilian production. As these statistical pictures are developed they will be published and turned over to the managements of industry to aid them in their indi-

vidual postwar studies and to provide a perspective against which the problems of each individual plant can be appraised.

A parallel study is concerning itself with the wartime dislocation of some 300 key industrial communities of the United States. We are assembling what might be called an economic description of each one of these communities. We shall know its population, the size of its total labor force, the distribution of its labor force by industries, and local economic functions. We shall know the distortion in the community's operating pattern that the war has produced. In terms of the outlook for each industry represented by the community's local plants, we shall be able to gain an insight into the postwar economic outlook for each community as a unit.

These studies will be published and made available to each industrial center of the country, and we hope that groups made up of businessmen, bankers, industrialists, farmers, and labor will use these facts in laying their plans for postwar adjustment.

Already some groups are at work. Gradually we are discovering who they are and establishing contact with them. We now are working with the Illinois Central Railroad, which, under the direction of Anderson Pace, its general industrial agent, has zoned the entire region served by the railroad and is organizing postwar committees in each zone. The railroad has taken the broadly intelligent view that its commercial future depends upon the economic future of the area through which its lines run. It has aided in the drawing together of groups without respect to whether or not they are customers of the Illinois Central, being concerned only with whether these groups are made up of businessmen, labor leaders, and others who will determine the economic future of the railroad's market area. Other regional organizations such as the New England Council are planning similar studies.

On the industrial scene the most outstanding accomplishment to date probably has been achieved by the General Electric Company, under the guidance of David C. Prince. General Motors, American Rolling Mills, The Sperry Corporation, du Pont, and others are at work. All of you know the story of the General Electric postwar program.

General Electric is making the only reasonable assumption that a business organization can make, which is, that after winning the war we shall not lose the peace—that we shall maintain a rate of gross national production of $110 billion a year. General Electric has checked that figure from the best available sources of information and has decided that it is real. Next, it has asked itself what a $110-billion gross national product implies for the electrical-manufacturing industry. Having estimated the total market for products of its industry, the company then asks itself what this means in sales volume for General Electric. That question can be answered only in terms of General Electric's many departments and manufacturing establishments.

In each department the engineering staff and sales force is being asked the questions, "What does that implied volume of overall business for General Electric mean in terms of the sale of the products of your department? Does General Electric now have the equipment needed to produce the implied volume of goods? What is the present wartime employment of your department? When war production ceases how much retraining will your employees need before they can be transferred to civilian production? How much retooling will be required to convert your shop from war output to the implied output of civilian goods? How much will that retooling and any necessary expansion cost? What capital outlay will be required to gear General Electric to serving markets implied by $110 billion of peacetime national output? Will General Electric have jobs for all of its defense workers?"

As answers are worked out by each department in General Electric they are brought together and integrated for the company as a whole. On the basis of that integrated picture that company will lay all its plans for the postwar period. It is going after its share of that $110-billion national market. Woe be to its competitors who fail to plan as well.

The job of every industry in the country is to do this kind of planning and to start it right now. Ask us in Washington for any assistance that we can give you but the detail work must be done by you. We shall be interested in the collective implications of your individual postwar plans. The business world's appraisal of what it can do will guide government in determining what it must do. War production will reach a peak of at least $50 billion per year. Postwar government expenditures of $50 billion per year would be fantastic. $25 billion would be equally fantastic. The objective of both business and government is to achieve an economic adjustment that will make it possible to select a level of government expenditures based on one prime consideration. That consideration should be the public's choice between highways, hospitals, schools, or public services, on one hand, and shoes, radios, shirts, and dresses on the other. What must not happen is a recurrence of the situation of the 1930's that forced the government to make inefficient needless work for millions while subsidizing the idleness of other millions who were willing and anxious to work. With business and government each fulfilling its respective economic function it will not happen again. Today we are wise to this financial system of ours; it no longer can push us around.

I should like to close the discussion with a comment about the period of adjustment that immediately will follow our victory over the axis powers. It is possible that when peace finally is won as many as 20 or 25 million American workmen may be engaged in the armed forces and directly or indirectly in wartime production. Production of many war items will have to be stopped almost immediately. Production of other items such as ships, certain types of aircraft, and clothing can be continued and tapered off gradually. But the dislocation produced by peace is bound to be violent. Government must be prepared to put the people who lose their wartime jobs in the early months after the peace to work on desirable public projects.

There is plenty to do in the field of public construction and other projects not competitive with business enterprise to carry us adequately through the immediate period of transition, provided that we plan well in advance. The anxiety of those of us in Washington who are planning this step into the breach is over how long we shall have to stay there. If the free enterprise system and our democratic institutions are to be preserved, the breach must be narrowed quickly by the plans and efforts of business. If business will lay its plans now with the thoroughness and comprehensiveness exhibited by General Electric, Illinois Central, and other private agencies, it should not be necessary for government to carry the load very long. The faster those 25 million people find civilian jobs in private industry the more rapidly will government's economic function be pushed back to its normal and desirable relationship to the community as a whole.

Business will do the jobs for which it is suited; government will handle the jobs best executed through public administration. Several of government's functions will be new and large as compared with 1929 or even 1939. But blueprints for prosperity are not being and could not be drawn in Washington. Individual business organizations the country over will make the business plans. Government will maintain the environment in which the plans may be realized. Give the nation a common will, shared by business and government, that it shall be done, and we will win the peace.

FIG. 1 REAR VIEW OF THE FIRST SECTION OF 16-STATION GREENLEE AUTOMATIC TRANSFER MACHINE USED IN PRODUCTION OF WRIGHT CYCLONE CYLINDER HEADS

MASS PRODUCTION *for the* AIRCRAFT-ENGINE INDUSTRY

By H. E. LINSLEY

WRIGHT AERONAUTICAL CORPORATION, PATERSON, N. J.

UNTIL the year 1939, the Wright Aeronautical Corporation had been producing in small lots varying from one to rarely more than fifty engines. Not only was the total output quite small, but more than a score of different models were in production, all of which were subjected to major or minor changes as the continuous development program proceeded. Under such conditions, therefore, the use of special-purpose, high-production equipment would have been entirely unjustified. It is axiomatic indeed that such equipment, in order to warrant its high original cost, should operate on a full-time basis, a condition which was obviously impossible with the then current production schedules. And with very few exceptions, therefore, all production was carried on by the use of standard turret lathes, drills, milling machines, and the like.

With the outbreak of war in Europe, however, there came a sudden demand for large quantities of engines of a single type, and for the first time it became feasible to consider the possibilities of straight-line production. There was no precedent upon which calculations could be based or any guarantee that it would be possible with automatic equipment to hold the extreme accuracy and fine finishes demanded for this class of work; and while we were much concerned with obtaining the maximum output in the minimum time, it was necessary to proceed with reasonable caution. Furthermore, the type of equipment we envisaged required considerable time to design and build, and our first step, therefore, consisted of installing such special machine tools as could be obtained in a reasonably short time and using them as a proving ground to test the practicability of production ideas such as had never been tried in our industry.

Output was almost immediately doubled, but this was far from being sufficient to meet the ever-increasing demands of Great Britain and France. Additional floor space was imperative, and a new plant was therefore constructed adjacent to the original one. Of single-story construction, this factory covered twelve and a half acres in a single building and was erected in the incredibly short time of 57 working days. It was devoted exclusively to the production of cylinders and crankcases, and functioned so efficiently that within a few months three additional existing factories were taken over and reconditioned in order that other engine components might be produced in relative quantities. Existing foundry facilities were enlarged and a new foundry was built for the production of cylinder

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heads, and shortly thereafter the country's first magnesium foundry for aircraft parts was constructed.

In the meantime the rising tide of totalitarianism threatened to engulf not only Europe, but the Americas as well. Hitherto, America had contented herself with supplying the means whereby others might resist; now she herself must "take up arms against this sea of troubles, and by opposing, end them." For this, aircraft above all were needed, and we of the Wright Aeronautical Corporation were faced with the problem of redoubling our already redoubled production.

The first step in this program was the erection of a new plant in the intermountain area, but even before the site of this was selected, production planning was started. The requirements called for the production of a single type of engine, the 1700-hp Cyclone 14. Developed from an earlier but still current 1600-hp model in which engineering and manufacturing difficulties had already been straightened out, this engine was not susceptible to any but minor changes—a factor which greatly simplified production without, however, being permitted to exert too great an influence. In order that production should not be too much delayed, the first schedules were prepared for manufacturing in limited quantities with the aid of standard equipment which could be obtained comparatively easily, while at the same time operation sheets were prepared so that mass production could be started immediately the new and special equipment was delivered.

Construction work, meanwhile, was started near Cincinnati, Ohio, on a 50-acre single-story building, of which one unit, the machine shop and assembly building, covered 33 acres, and 157 days after breaking ground production was started. The "motif" of this whole factory is the straight line, a plan which is carried out even in the architectural design and which governs the entire machine-tool layout.

Starting at one end of the building where rough stock is received, the parts progress steadily forward until they reach the barrier formed by the final inspection benches, over which they must pass before reaching the assembly floor, which is itself laid out for progressive line assembly.

It would be ungracious not to say a word here in praise of the machine-tool builders who have thrown themselves so wholeheartedly into the task of solving the almost impossible problems set them and who have in the last year or so developed machine tools such as the world had never before seen and whose accuracy and automatic operation is positively uncanny.

Not all of this equipment is basically new; much of it indeed was evolved as the result of a careful study of methods and machines used in the automobile industry and was the result of our decision to utilize such parts of these as seemed most applicable to our own product. These studies included a thorough investigation as to costs, and in most cases it was found that the special machines would actually cost less than the large number of standard machines which would be required to perform an equal amount of work. In the few cases where the cost was higher, it was found that this difference would be paid off within a very few months by the reduced manufacturing costs. A further but highly important factor was the reduction in floor space achieved by the use of these machines, a factor which greatly influenced the size of the building to be constructed. Altogether, 22 special machines are giving a work output which would normally demand the services of 154 standard machines.

Of all this varied equipment undoubtedly the most interesting is the huge Greenlee automatic transfer machine for the machining of cylinder heads. Reduced to its simplest terms, this massive machine may be considered as a series of individual, multiple-spindle machine tools arranged along both sides of an automatic conveyer, and is in itself a production line. In place, however, of having to locate the part in a fixture, clamp it, machine it, unclamp it, remove it from the fixture and place it on the conveyer, these functions are handled automatically. It is indeed chiefly by this saving in handling time that the economies have been effected, since feeds and speeds did not permit of any substantial increase. Actually there are two of these machines, but since they are set up one behind the other, and since parts are fed directly from one to the other, they may be considered as virtually one machine. The first section, Fig. 1,

FIG. 2 LOADING END OF 56-STATION SECTION OF THE GREENLEE TRANSFER MACHINE SHOWING MASTER CONTROL BOARD

has a length of 21 ft and comprises 16 stations, 10 of which are active or operating stations, and the remaining 6, mere bridges between the units. These spaces between the units are essential to allow the operator to have access to the individual tools for adjustments or replacements. Not all of these units, however, are in operation at the same time, since some are used only on heads required for the front row of cylinders, while others are used only on rear-row heads. Altogether, 25 different operations are performed on front heads, employing a total of 64 separate tools, and 20 operations on the rear heads, using 47 tools. As the parts leave the first machine, they pass through a washer where oil and chips are removed and are then given a quarter turn before passing along a standard roller conveyer to the second machine. The second machine, Fig. 2, is 73 ft long and comprises 56 stations, of which 23 are operating stations, two are gaging stations, and the remainder, bridges. Forty-six operations are performed with 70 tools on front heads and 37 operations, using 61 tools on rear heads. A second washer cleans the parts as they emerge at the rate of one every 48 sec. Altogether there are 44 drills, 46 reamers, 39 countersinks, 4 spotfacers, 8 counterbores, 4 boring tools, 2 facing tools, and 37 taps. Fig. 3 shows the discharge end of the machine before the wash machine was delivered.

The two machines between them have a total of 40 electric motors taking 190 hp, and in order to avoid excessive starting loads on the main power lines these are started at intervals by means of an automatic timer. This interval at present is 2 sec but may be varied as required. They are operated on 440-volt current, but for the control system this is reduced to 110 volts so as to reduce the danger of burning the silver contact points through arcing. The entire control system is enclosed in a moisture- and dust-proof housing. All the functions of the machine, including the movement of the work heads, the clamping and unclamping action, and the action of the transfer bar, are controlled by limit switches and are so interlocked electrically and hydraulically that each cycle must be complete before any further action can take place. Or in other words, once the automatic cycle button has been pressed, the transfer bar must travel its full in-and-out stroke, the locating pins must engage, the clamps lock down, the work heads all advance the full amount of their feed and then withdraw completely, the clamps unlock, and the locators disengage before the signal lamp will light to indicate that another part may be placed into the machine and the cycle repeated. Should any one of these functions not be completed for any reason at all it will be impossible to start the next cycle. In a machine of this size it would normally require considerable time to locate the source of trouble, but this is taken care of by means of a master indicator board carrying three sets of colored lamps. These are numbered to correspond with the station numbers and are connected to the various limit switches, one set for the clamping position, one for the unclamping position, and one to indicate that each of the units has completed its feed stroke to full depth. In addition to these there is a lamp which indicates that all the units are clear back ready for the next cycle, another which lights automatically when the machine is ready for the next cycle, and a third which remains lighted while the motor for driving the transfer and clamp hydraulic pump is running. In the event that the automatic signal lamp does not light within a reasonable time, the operator closes in succession the three master switches on the control board. These cause the signal lamps to light except the one which is cut out through failure of the limit switch to close. The number of this lamp indicates the station at which trouble is present, while its location in the first, the second, or the third group shows what the type of trouble is.

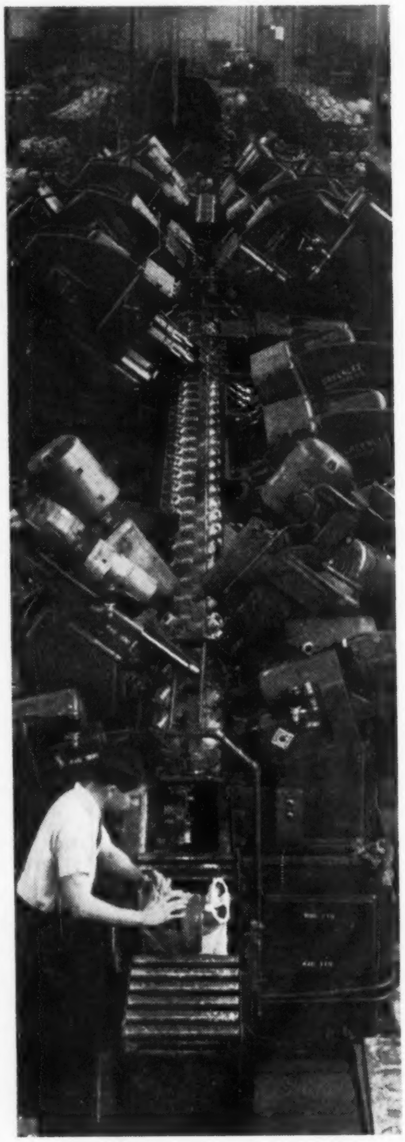


FIG. 3 END VIEW OF COMPLETE GREENLEE TRANSFER MACHINE SHOWING OPERATOR REMOVING A COMPLETED CYLINDER HEAD

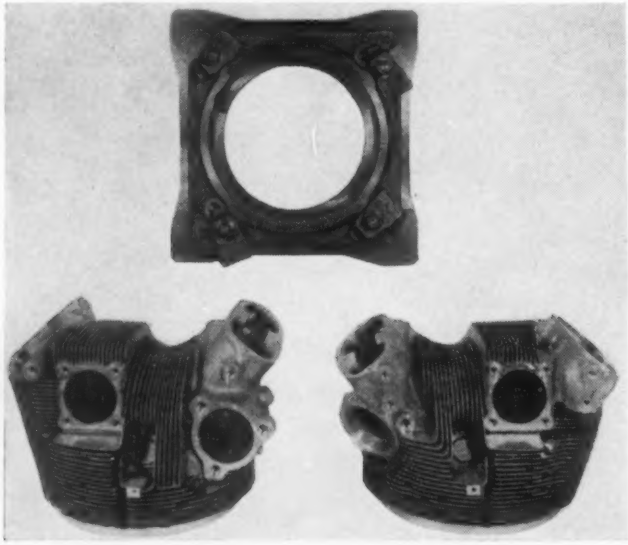


FIG. 4 FRONT AND REAR CYCLONE CYLINDER HEADS AND SPECIAL MOUNTING PLATE (ABOVE) ON WHICH THESE ARE CARRIED THROUGH THE GREENLEE MACHINE

A central coolant system is installed with a main tank holding 1650 gal, and the oil is supplied by pumps handling 550 gpm. Each individual distribution pipe is equipped with an automatic valve so that the coolant flows only while the cutting tools are operating. Chips are washed into a trough below the machine and carried by the flow of oil into a catch basin with a capacity of 18 cu ft.

The actual operation of the machine is as follows: Referring to Fig. 4, the cylinder heads are clamped onto drop-forged hardened-steel carrier plates equipped with bushings to receive the locating plugs, the correct position of the parts being

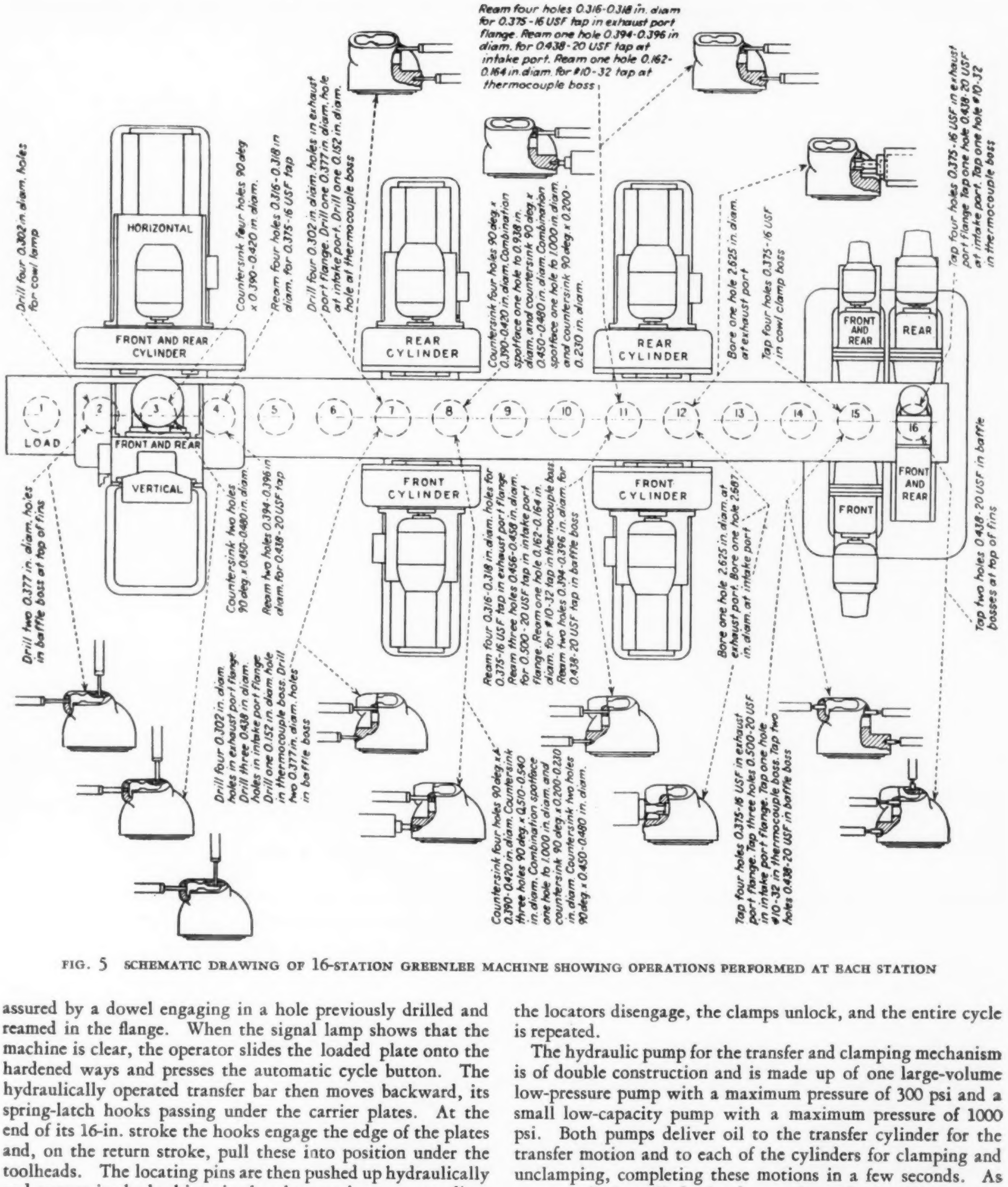


FIG. 5 SCHEMATIC DRAWING OF 16-STATION GREENLEE MACHINE SHOWING OPERATIONS PERFORMED AT EACH STATION

assured by a dowel engaging in a hole previously drilled and reamed in the flange. When the signal lamp shows that the machine is clear, the operator slides the loaded plate onto the hardened ways and presses the automatic cycle button. The hydraulically operated transfer bar then moves backward, its spring-latch hooks passing under the carrier plates. At the end of its 16-in. stroke the hooks engage the edge of the plates and, on the return stroke, pull these into position under the toolheads. The locating pins are then pushed up hydraulically and engage in the bushings in the plates to insure exact alignment. These pins are operated by the same cylinders which do the clamping and are so arranged that at the end of their inward stroke the pressure from the clamp cylinder is applied against the upper edge of the carrier plates and holds these down on the ways. The toolheads then advance and machining starts. Rapid advance is used on all tools, and it is interesting to note here that two rates of feed are used on facing tools. When all operations have been performed, the tools withdraw, the locators disengage, the clamps unlock, and the entire cycle is repeated.

The hydraulic pump for the transfer and clamping mechanism is of double construction and is made up of one large-volume low-pressure pump with a maximum pressure of 300 psi and a small low-capacity pump with a maximum pressure of 1000 psi. Both pumps deliver oil to the transfer cylinder for the transfer motion and to each of the cylinders for clamping and unclamping, completing these motions in a few seconds. As soon as all the cylinder heads are clamped, the oil from the large pump is automatically by-passed and the pressure at the small pump is increased from 300 psi to just under 500 psi, where it remains during the work cycle to hold the heads firmly in place.

To attempt to give particulars of all the various operations performed at each station would be to involve a mass of entirely useless detail, but Fig. 5 shows quite clearly just what is done at each of the 16 stations of the first machine. It will be

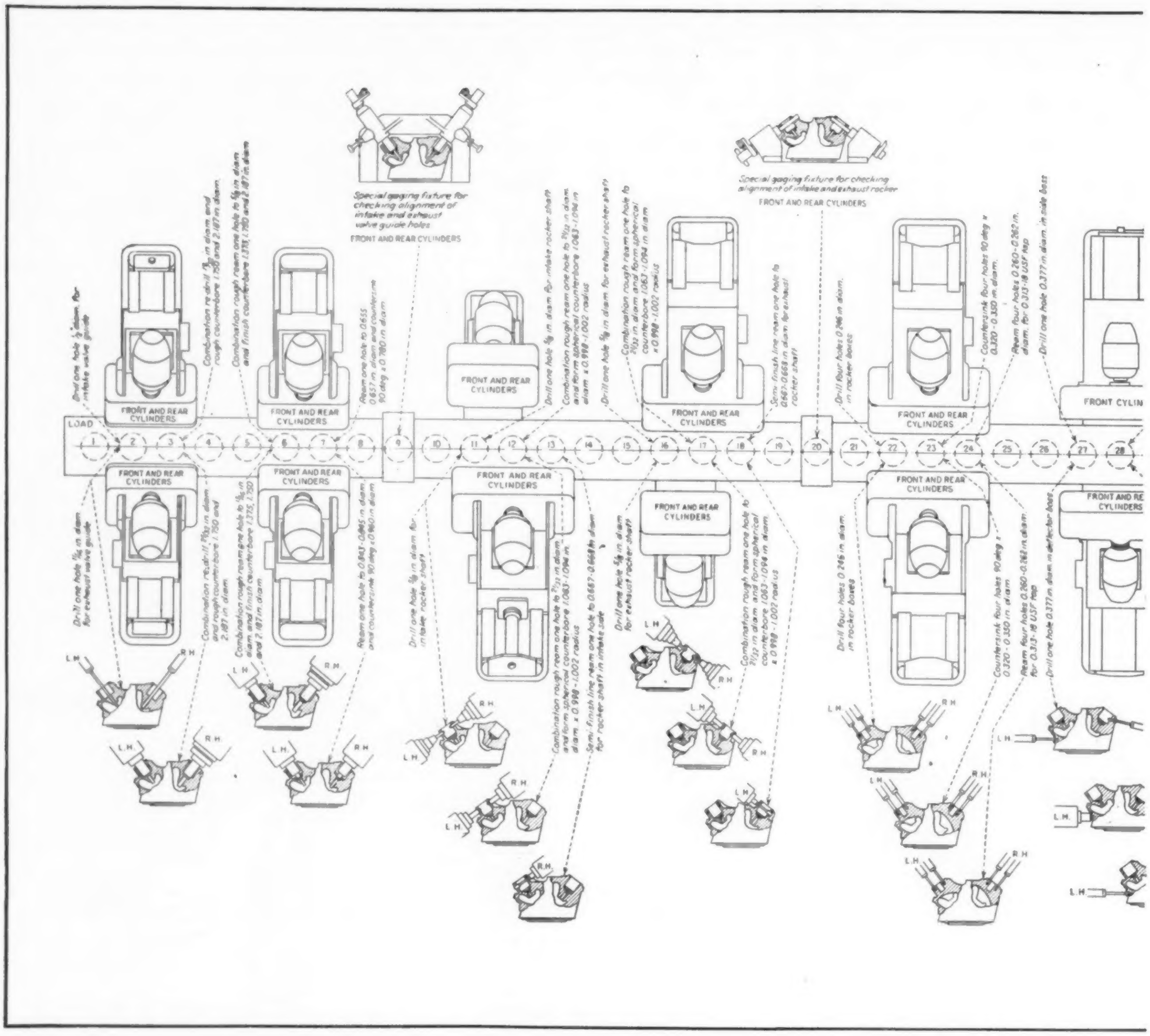


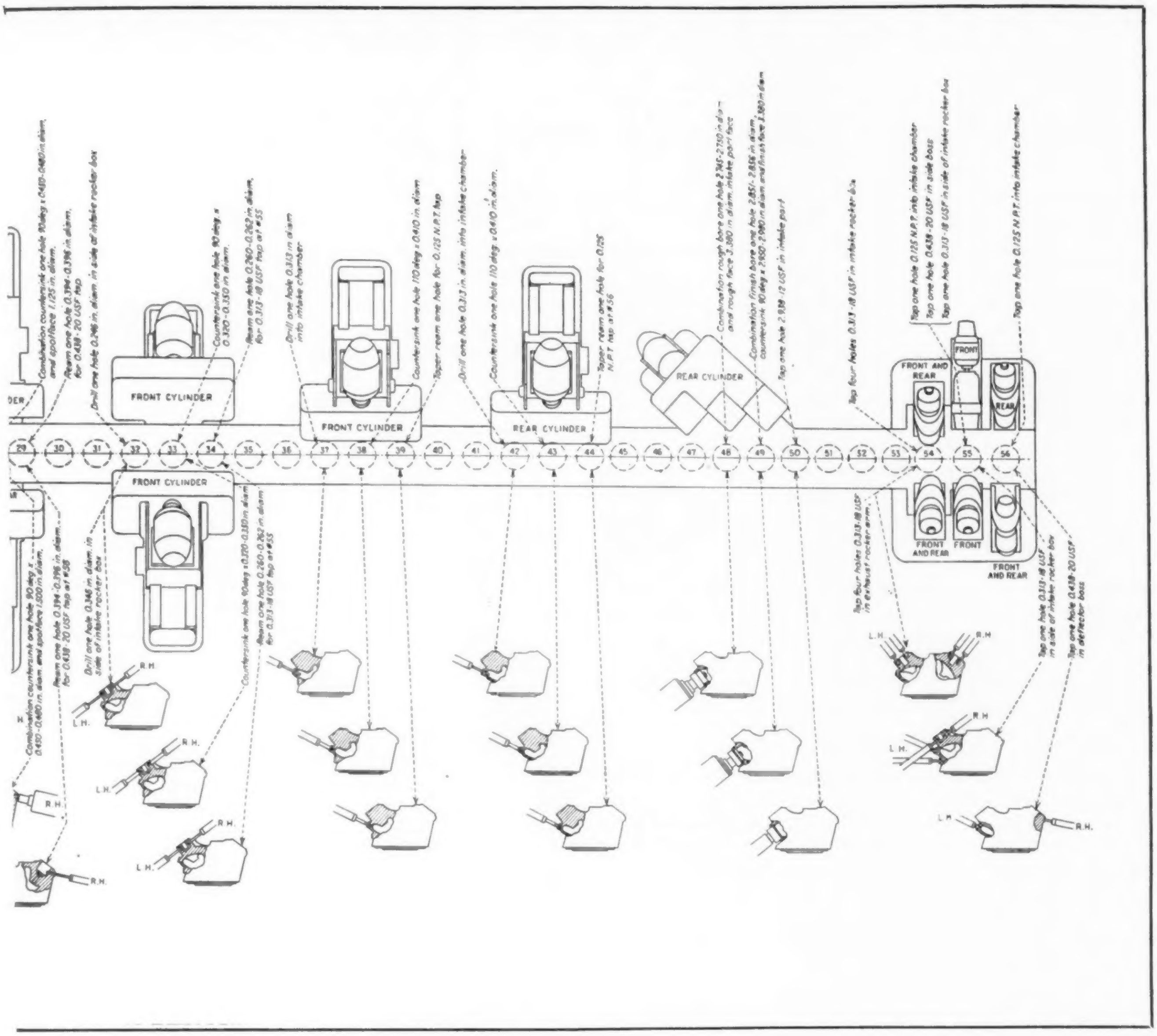
FIG. 6 SCHEMATIC DRAWING OF 56-STATION GREENLEE MACHINE

noted that at the two last stations tapping operations are performed. These units are the only ones not hydraulically operated, being driven instead by a lead screw to insure accuracy and to avoid damaged threads.

Fig. 6 shows the operations performed on the 56-station machine. The operations on this are similar to the other and again all taps are lead-screw-operated. The unit at stations 48, 49, and 50 is perhaps worth noticing since this operates at a compound angle to rough and finish bore, face, chamfer, and tap the intake port of the rear cylinder—an operation not performed on front heads. After leaving this machine the parts are passed through a washing machine and the carrier plates are removed and returned to the loading bench, while the heads move on for the final machining and assembling operations.

The nature of the work itself and the transfer mechanism used prohibit the use of end-piloted tools, and in order to preserve the accuracy so essential in aircraft-engine work, overhang has been reduced to a minimum and spindles are noticeable for their unusually large diameter. Jig plates are used to guide drills and reamers, antifriction bearings are used throughout, and ways are hardened and ground. With the exception of taps and small-diameter drills and reamers, all tools are carbide-tipped.

The first cost of this machine was naturally high, almost a quarter of a million dollars, but against this must be set the tremendous savings effected by it. In the first place, 39 standard and special-purpose machines would be required to give equal production, machines urgently needed by other manufacturers, and a substantial load is thereby removed from the already heavily overburdened machine-tool industry. Secondly, only ten men per shift are required to operate it, as against 35 who would be required otherwise. Of these ten, only one needs to be fully trained, the remainder being unskilled, whereas with the old system, the entire 35 were required to be at least semiskilled, and a goodly proportion of skilled setup men had to be included. The number of skilled men being at present extremely limited, this has enabled us to employ these to better advantage as foremen and lead men. In the third place, the actual production time per cylinder head has been reduced from 59 man-minutes to only 8 man-minutes, and fourthly, the amount of floor space required is only 2890 sq ft as against 7448 sq ft for the 39 machines previously mentioned.



SHOWING OPERATIONS PERFORMED AT EACH STATION

Getting back to the matter of first cost, it is estimated that this machine represents an increase of about $77,000 over the semiproduction type, but this difference will be made up in about six weeks at full production and the machine should pay for itself entirely within about six months.

Although designed to perform certain specific operations, the machine nevertheless possesses a certain flexibility in view of the fact that the individual units are tied together only by the transfer bar and ways. If then it should be desired to incorporate additional operations, all that is necessary is to open up the transfer bar at one of its joints and insert a new section of suitable length. The new units may then be placed in position and coupled to the electric and hydraulic system, provision having been already made for this on the control panel. This procedure would, of course, involve also unbolting certain machines from the floor and shifting them further down the line. Similarly, any unit may be removed or merely made inoperative if no longer required. In the event of a mechanical breakdown the unit affected may be made inoperative and the operation thus omitted may be performed later on standard equipment until such time as repairs or replacement can be effected.

Amazing as this machine is, it is still not the ultimate; indeed it may prove to mark but the beginning of a new era of automatic production equipment. Already another such machine is in course of manufacture for our Paterson plant, a machine which will not only produce front and rear heads for the 14-cylinder engine but will also handle the substantially different head used on the 9-cylinder engine, and in addition to performing all the operations done on the present machines it will also carry out several milling operations. What this will mean when wartime production ceases is hard to tell, but one thing seems certain, that if the manufacturers of aircraft can adopt similar methods, and there is no reason why they cannot, then flying will become so cheap and so commonplace that there will be scarcely a town or hamlet that is not linked to a vast network of airways.

As the world's great highways were first built and used for war but remained to carry commerce and civilization within their limited span, so the aircraft, perfected by the needs of war, may yet be the means whereby nations shall learn to know one another as neighbors, and as neighbors, live together in peace.

MANUFACTURE *and* PROCESSING *of* ALUMINUM *and* ITS ALLOYS

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MOST outstanding quality of the aluminum alloys is their low specific gravities as compared to other commonly used metals. Roughly, the aluminum family of alloys weighs only one third as much as equal volumes of steel, copper, brass, and bronze. In addition, their tensile strengths range from 13,000 psi in the soft, relatively pure aluminum to tensile strengths comparable to those of structural steel in the so-called strong alloys. As a consequence, aluminum alloys are pre-eminently suited for applications where the conservation of weight is an important factor. Indeed, their application is so extensive in the aircraft industry that aluminum has come to be known as the airplane metal. The recently proved military value of the airplane, moreover, has created such a demand for aluminum alloys that the whole world has become aluminum-conscious. This paper, therefore, has been prepared for the benefit of those engineers who wish to become more familiar with aluminum, its preparation, and the fabrication of its alloys into wrought products.

HISTORICAL

Aluminum is the third most abundant element available. Clark estimates aluminum to constitute about 7.85 per cent of the earth's crust. Aluminum never occurs in the native form, and because of the element's great affinity for oxygen, aluminum, with the exception of its fluorides, invariably occurs as oxidized compounds.

Alum, from which the element takes its name, was known to the Greeks and Romans. As early as 1746 Pott showed that alum was derived from a peculiar earth which he called "alumina." Davey, who always regarded this earth as an oxide of a metal, eventually isolated the metal in an impure form in 1807 and called it "aluminum." The pure metal was first isolated in 1825 by Oersted, and two years later by Wöhler. In 1886 Hall, in the United States, and Héroult, in Europe, simultaneously began the production of aluminum by the electrolysis of aluminum oxide dissolved in a molten bath of cryolite. This process, which made commercial production of aluminum feasible, is now responsible for the entire world's production of the metal.

REDUCTION OF ALUMINUM

Because in the electrolytic reduction of aluminum oxide any impurities such as the oxides of iron, silicon, and titanium are reduced along with the alumina, an oxide of high purity must be used. As a consequence, the manufacture of metallic aluminum comprises two main stages: The first stage embraces the production of pure alumina, Al_2O_3 from the ore, and the second comprises the electrolytic reduction of the pure Al_2O_3 to metallic form in a bath of molten cryolite.

Although a number of commercial methods have been developed for the production of high-purity Al_2O_3 from aluminous materials, the Bayer process is almost universally used for the purification of bauxite. Inasmuch as an overwhelming preponderance of metallic aluminum is manufactured from bauxite, the Bayer process is by far the most extensively used method for the extraction of pure alumina. In outline form the Bayer process is as follows:

1 Bauxite is dried in rotary kilns.
2 The dry bauxite is ground very fine, usually in ball mills.
3 The pulverized material is dissolved with strong sodium-hydroxide solutions in autoclaves at a temperature of 150 C under pressures of four to five atmospheres.
  (*a*) Al_2O_3 is dissolved as sodium aluminate.
  (*b*) Iron, silicon, and titanium remain insoluble.
4 Solutions are diluted and allowed to settle four or five hours.
5 Settled solutions filtered.
6 The aluminum is precipitated as $Al(OH)_3$ by adding freshly precipitated crystals of $Al(OH)_3$.
  (*a*) Precipitation usually requires sixty hours.
7 $Al(OH)_3$ is filtered out of the solution and washed.
8 The pure $Al(OH)_3$ is roasted in rotary kilns to yield Al_2O_3.

The electrolytic reduction is carried out in large cells which are essentially steel boxes lined with carbon and filled with molten cryolite. Carbon anodes are suspended in the tops of the cells while the carbon linings function as the cathodes. Numerous types of cells are in use. As many as twelve separate anodes may be used in one cell, or only one huge anode may be employed.

The cells, or pots, as they are called within the industry, are operated at temperatures of about 1000 C. At this temperature the cryolite is able to dissolve approximately 10 per cent of its weight of alumina. Current densities of 4 to 8 amp per sq in. are used. The passage of such large current densities generates sufficient heat to maintain the bath temperature so that external heating is not necessary.

The theoretical decomposition electromotive force is considered to be 2.8 volts with a theoretical current consumption of 1337.5 amp-hr per pound of metal. Consequently, the theoretical energy requirement amounts to 3.75 kwhr for every pound of aluminum reduced. In practice, cell voltages of 4 to 6 volts are common, while current efficiencies of 70 to 90 per cent are usually reported. For the commercial reduction of metallic aluminum, therefore, each pound of metal requires from 10 to 11 kwhr of electrical energy.

As electrolysis progresses, alumina is consumed in direct proportion to the amount of metal reduced. Additional alumina is supplied to the impoverished bath by stirring it into the surface. The metallic aluminum, having a greater specific gravity than the molten cryolite bath, collects in the bottom of the cell. When a sufficient amount of metal accumulates, it is drawn off and cast into pig ingots. Metal may be drawn from a cell every few minutes, every day, or every third day, depending

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upon the design of the cell and local operating conditions. Every attempt is made to keep the purity of the virgin pig as high as possible.

STRENGTHENING OF ALUMINUM

Aluminum of high purity is relatively weak, but it possesses excellent plasticity. Approximately, its tensile strength is only one fourth to one fifth that of structural steel. Obviously, the utility of aluminum would be greatly limited were it not possible to increase its strength and hardness. The art of metal-working and the science of metallurgy, fortunately, have developed three general methods of strengthening and hardening metals, as follows:

1 Strain hardening by cold work.
2 The addition of other metals and metalloids to form alloys.
3 Thermal treatment of certain types of alloys.

These three methods of metal hardening have been applied to aluminum, giving rise to two commercial classes of alloys which are generally known as common and strong alloys.

COMMON ALLOYS

The common alloys derive their increased strength in the annealed condition by virtue of the alloying elements employed. Further increases in the strength of the common alloys can be obtained only through the introduction of cold work, as by cold-rolling, wire- or tube-drawing, cold-swaging, and the like. They are not amenable to hardening by thermal treatment. Examples of the common alloys in most general use are 2*S*, 3*S*, and 52*S*. The alloy 2*S* is aluminum of commercial purity containing a minimum of 99 per cent aluminum with controlled amounts of silicon, iron, and copper as impurities.

STRONG ALLOYS

In 1911, Wilm in Germany discovered that certain aluminum alloys when water-quenched from high temperatures exhibit remarkable increases in strength and hardness after several days' aging at room temperature. His discovery led directly to the development of Duralumin and pointed the way to the development of the numerous heat-treatable alloys of aluminum in existence today. Because of the greater strength of these latter alloys, as compared to the older alloys of aluminum, they were called strong alloys.

As we have seen, strong alloys owe their greater strength principally to the state of their physical structures as induced by thermal treatments. These alloys have a remarkable ability to age-harden. In general, two types of strong alloys exist: Those which completely age-harden spontaneously at room temperatures, and those which require slightly elevated temperatures to develop complete age-hardening. Alloys 17*S* and 24*S* are examples of the former class, while 25*S* and 51*S* are examples of the latter class.

In order to develop age-hardening in strong alloys, it is first necessary to subject them to a solution heat-treatment. This consists of heating the alloys to the highest temperatures used in the thermal treatment of aluminum alloys. These high temperatures are maintained long enough to obtain saturated solid solutions of the particular alloying constituents in the aluminum space lattice; and at the end of the so-called soaking period the metal is drastically cooled by a sudden quench in cold water. The cooling is so sudden that the solid solutions are temporarily retained at the lower temperatures in a state of unstable thermodynamic equilibrium. In the aluminum industry the whole cycle of heating, soaking, and quenching is called the heat-treatment or heat-treating operation. Immediately after the quenching the alloys possess characteristics typical of solid solutions. In this condition they are relatively soft and plastic. Age-hardening develops rapidly, however, in those alloys which age-harden spontaneously at room temperatures, so that very appreciable increases in tensile strengths occur within one hour after the quenching operation. By the end of three or four days the aging process is practically complete, and the alloys are in their fully age-hardened condition. In those alloys requiring elevated temperatures to develop age-hardening after the quench very little hardening occurs at room temperatures. These alloys remain relatively soft and plastic and, consequently, are readily formed in the as-quenched condition. Full hardness is developed by reheating to moderate temperatures at any convenient time after the quench. The hardening which develops by aging at room temperature or at slightly elevated temperatures results from the slow precipitation of the solute constituents from the unstable solid solutions. The exact mechanism of the precipitation process is not completely understood at this time, and the whole subject is under intensive investigation. It is believed that the finely dispersed particles of the precipitate orient themselves within the solid-solution matrix in such a manner as to increase resistance to slippage along the crystallographic slip planes of the parent lattice.

Apparently, there is sufficient atomic mobility at room temperature to allow the precipitation to proceed sufficiently to develop hardness in the spontaneous-aging type of alloys. In the alloys which do not completely harden spontaneously at room temperature, sufficient atomic mobility is obtained for precipitation of solute constituents by holding the alloys at temperatures of 300 to 350 F for periods of time ranging from eight to twenty-four hours. The reheating after quenching is frequently referred to as precipitation heat-treatment or artificial aging.

REMELTING

The first step in the conversion of pig aluminum to wrought commodities of engineering value comprises remelting and casting operations.

Except for very specialized cases of certain types of aluminum-alloy scrap which is always fed into the remelting furnaces along with the virgin pig, little or no refining can be accomplished by the remelting operation. Consequently, we may say the purpose of aluminum remelting is twofold:

1 To add the required alloying elements.
2 To cast the metal into finished or semifinished products, or into convenient shapes for subsequent fabrication into wrought commodities.

Because the scope of this paper is limited to the production and processing of wrought products, only wrought alloys will be discussed.

The open-hearth type of furnace is used almost exclusively for remelting wrought aluminum alloys. Essentially, these furnaces consist of a shallow hearth and suitable heating arrangements. In this country the hearths are generally lined with firebrick, but in Europe the tendency seems to be toward the use of the more expensive magnesite-brick linings.

Heating is accomplished by the conversion of electrical energy to thermal energy, or by the combustion of fuels such as coal, gas, oil, and coke. Coke-fired furnaces are by far the most prevalent in the United States.

The elements most commonly used in the production of commercial wrought aluminum alloys are copper, magnesium, silicon, manganese, iron, zinc, chromium, and nickel. They may be used singly or in combination, but the total content of alloying elements in a given alloy is seldom more than 6 or 7 per cent. Except for the magnesium and zinc, the alloying elements are generally added to a bath of molten pig and scrap

in the form of auxiliary or so-called hardener alloys. Copper, for example, is added in the form of a 33 per cent copper alloy of aluminum corresponding to the eutectic composition for the copper-aluminum system, and manganese is added in the form of a 5 per cent manganese auxiliary alloy of aluminum. The metals zinc and magnesium are generally added in commercially pure form by means of special tools, by which the metal is kept completely submerged under the surface of the bath so as to prevent excessive oxidation. Having obtained the desired alloy in the molten condition, the metal is cast into ingots of convenient size and form for the forming operations.

FORMING OPERATIONS

Pure aluminum and the wrought alloys of aluminum are available in numerous forms, such as foil, sheet, plate, wire, rod, bar, tubing, rolled structural shapes, and a multitude of oddly shaped extrusions. Aluminum alloys, like most metals and alloys, are relatively brittle in the cast state, and, consequently, the first forming of the ingots must be conducted at elevated temperatures where the increased ductility and plasticity will prevent cracking and breaking under the pressures and forces applied. The first hot-forming operation employed depends on the final product desired. For sheet and plate products a relatively thin, long, wide ingot is rolled between cylindrically shaped rolls. A long ingot with a square cross section, on the other hand, is hot-rolled in a box-shaped pass as the first step in the production of rod, bar, and certain structural shapes. Cylindrically shaped ingots are usually employed for extrusions, including tubing, rod, and variously shaped cross sections.

In all but the simpler common alloys and high-purity aluminum compositions, a preheating operation is required prior to the first step in hot-forming. The preheating serves to homogenize and soften the cast structure, making it more amenable to forming without fracture. The preheating temperatures range from 850 to 900 F, depending on the alloy and type of ingot. The temperatures of the metal during hot-forming also vary from 500 to 900 F, depending on the type of alloy and the stage and type of hot-forming processes. Many products are hot-worked to finished form. Some examples are extruded shapes, certain types of rod and bar, rolled shapes, and heavy plate. In the fabrication of other products, such as wire, cold-finished rod and bar, tubing and sheet, the hot-working is followed by cold-forming processes, such as wire-drawing, tube-drawing, cold-swaging, and cold-rolling. As cold-forming proceeds, the metal is hardened by virtue of the cold deformation, so that intermediate annealing operations are required from time to time in order to soften the metal sufficiently for reduction to final form. In the common alloys the tensile strength and degree of hardness, i.e., the temper, is governed by the amount of cold deformation introduced subsequent to the last annealing operation.

Many products, such as extruded shapes, cannot be cold-worked appreciably, and, consequently, such products when fabricated in the common alloys, cannot be produced with controlled tempers, except for the soft or annealed temper.

TABLE 1 NOMINAL COMPOSITION OF WROUGHT ALUMINUM ALLOYS

	Percentage of alloying elements—aluminum and normal impurities constitute remainder				
Alloy	Copper	Silicon	Manganese	Magnesium	Chromium
2S	...	...	...	...	..
3S	...	...	1.2	...	..
17S	4.0	...	0.5	0.5	..
24S	4.5	...	0.6	1.5	..
25S	4.5	0.8	0.8	...	..
51S	...	1.0	...	0.6	..
52S	...	...	...	2.5	0.25

TABLE 2 TYPICAL MECHANICAL PROPERTIES OF WROUGHT ALUMINUM ALLOYS

	Tension				Hardness	Shear	Fatigue
			Elongation, per cent in 2 in.				
Alloy and temper	Yield strength (set = 0.2%), psi	Ultimate strength, psi	Sheet specimen (1/16" thick)	Round specimen (1/2" diam)	Brinell 500-kg load, 10-mm ball	Shearing strength, psi	Endurance limit, psi
2S-O	5,000	13,000	35	45	23	9,500	5,000
2S-1/4H	13,000	15,000	12	25	28	10,000	6,000
2S-1/2H	14,000	17,000	9	20	32	11,000	7,000
2S-3/4H	17,000	20,000	6	17	38	12,000	8,500
2S-H	21,000	24,000	5	15	44	13,000	8,500
3S-O	6,000	16,000	30	40	28	11,000	7,000
3S-1/4H	15,000	18,000	10	20	35	12,000	8,000
3S-1/2H	18,000	21,000	8	16	40	14,000	9,000
3S-3/4H	21,000	25,000	5	14	47	15,000	9,500
3S-H	25,000	29,000	4	10	55	16,000	10,000
17S-O	10,000	26,000	20	22	45	18,000	11,000
17S-T	40,000	62,000	20	22	100	36,000	15,000
Pureclad *17S-T*	33,000	56,000	18	..	...	32,000	...
24S-O	10,000	26,000	20	22	42	18,000	12,000
24S-T	45,000	68,000	19	22	105	41,000	18,000
24S-RT	55,000	70,000	13	..	116	42,000	...
Pureclad *24S-T*	41,000	62,000	18	..	...	40,000	...
Pureclad *24S-RT*	50,000	66,000	11	..	...	41,000	...
25S-T	35,000	57,000	18	..	...	...	...
51S-O	6,000	16,000	30	35	28	11,000	6,500
51S-W	20,000	35,000	24	30	64	24,000	10,500
51S-T	40,000	48,000	14	16	95	30,000	10,500
52S-O	14,000	29,000	25	30	45	18,000	17,000
52S-1/4H	26,000	34,000	12	18	62	20,000	18,000
52S-1/2H	29,000	37,000	10	14	67	21,000	19,000
52S-3/4H	34,000	39,000	8	10	74	23,000	20,000
52S-H	36,000	41,000	7	8	85	24,000	20,500

S = Wrought alloys.
O = Annealed, soft temper.
H = Hard temper.
T = Fully heat-treated and age-hardened.
W = As-quenched (used only with alloys which require artificial aging).
RT = Strain-hardened after heat-treating.

FINISHING

Alloys which are amenable to hardening by thermal treatments are heat-treated after the product has been fabricated to finished dimensions. As explained previously, the heat-treatment consists of drastically quenching the metal in water from high temperatures. The sudden cooling causes considerable twisting and warping of the fabricated forms, so that straightening or flattening operations, or both, are required. Sheet

(*Continued on page 131*)

SYNTHETIC RUBBER

Its Development, Production Capacity, and Use

By O. M. HAYDEN

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SYNTHETIC rubber has become such an important engineering material that one may say, as in the case of rubber, "You can't do business today without synthetic rubber." It could as well be stated that a nation cannot successfully defend itself or carry on aggressive warfare today without using synthetic rubber both directly and indirectly for military purposes. The strongest evidence of this lies in the fact that the distribution of synthetic rubbers in this country has been placed under the mandatory control of the government to insure priority with respect to use for defense purposes.

Synthetic rubber has won this position of vital importance because, with the types that have been produced, innumerable products can be made that are vastly superior to those made from natural rubber; and of perhaps greater importance is the fact that products made from it possess properties which permit the design and operation of mechanisms that would otherwise be impossible.

HISTORY OF SYNTHETIC-RUBBER DEVELOPMENT

This paper will discuss the many uses for synthetic rubber without attempting to differentiate among the properties of the various kinds and types. But first it might be well to review briefly the history of its development and the present production status.

Rubber itself has never been synthesized, although there have been many attempts to do so. As early as 1860 Williams[1] identified isoprene among the products of the destructive distillation of natural rubber, and fifteen years later Bouchardat[2] recognized the relation of isoprene to rubber and converted it to a rubber-like solid. In 1884 Tilden[3] prepared a sample of isoprene from turpentine and in 1892[4] reported that it polymerized spontaneously to "rubber." However, no commercial process was developed for its manufacture because the cost of producing this rubber was calculated to be much in excess of that of natural rubber, and, moreover, the product was decidedly inferior to the natural product.

Inspired by the prevailing high prices of natural rubber, and presumably in part by the prospect of war, intensive research on synthetic rubber was carried out in England, Germany, and Russia during the years 1908 to 1914. The only tangible result was the production in Germany during World War I of about 2350 tons of an admittedly inferior product. With the return of peace, production was stopped and only desultory research was continued throughout the world until 1925, when the du Pont laboratories started an intensive program, the final result of which was neoprene.

Up to this time research had been directed toward the development of a synthetic material which would possess both the chemical composition and the physical properties of natural rubber. Because it did not seem probable that such a product could be produced at a cost which would be competitive with natural rubber, the problem was revised. The new goal was to develop a synthetic rubber which would be so outstandingly superior to the natural product that for many industrial uses it would be capable of finding a commercial market in free competition with natural rubber even though the price would be higher.

The first two products which were thereafter placed in commercial production were Thiokol, an organic polysulphide, and neoprene, a polymer of chloroprene. The production of Thiokol began in 1930, and that of neoprene early in 1931. Both were immediately put to use by the rubber industry, which quickly recognized the importance of their special property of resisting the action of solvents.

Concurrently, both the Germans and the Russians were at work on the development of synthetic rubber, but it appears that they were placing more emphasis on the search for a substitute for natural rubber than for a superior product. Both developed processes for obtaining butadiene and polymerized it in the presence of metallic sodium in accordance with methods discovered in 1910. The Germans named their synthetic rubber "Buna" from the first two letters of butadiene and the first two letters of natrium, the German name for sodium. The Russians designated their synthetic rubber by the initials of the Russian words for synthetic rubber, namely SK, followed by the letters A or B, depending upon whether the starting material was petroleum or alcohol.

The Germans observed that the quality of "rubber" obtained by polymerizing butadiene alone could be improved by polymerizing it in the presence of other polymerizable materials, and brought out two new synthetic rubbers which were made in this manner, namely, Buna S and Buna N. The trade name was later changed to Perbunan. Perbunan is made by polymerizing butadiene in the presence of acrylonitrile and is used in the manufacture of articles which need to be resistant to the action of solvents. In this respect it corresponds to the synthetic rubbers first made in this country. Buna S is made by polymerizing butadiene in the presence of styrene, and this is the synthetic rubber which is used in Germany largely for the manufacture of tires.

SYNTHETIC RUBBERS PRODUCED IN UNITED STATES

Until 1940 the commercial production of synthetic rubber in this country was limited to neoprene and Thiokol; some Perbunan was imported from Germany. During the year 1940 a number of manufacturers in this country announced in rapid succession new synthetic rubbers among which are the following familiar names:

Butyl rubber, developed by the Standard Oil Company of New Jersey. The composition of this synthetic rubber has not been made public and it has not yet been placed on the market in substantial quantities.

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[1] "On Isoprene and Caoutchine," by C. Greville Williams, Proceedings of the Royal Society of London, vol. 10, 1860, p. 516.

[2] "Action des hydracides sur l'isoprène; reproduction du caoutchouc," by G. Bouchardat, Comtes Rendus, vol. 89, 1879, p. 1117.

[3] "On the Decomposition of Terpenes by Heat," by William A. Tilden, *Journal of the Chemical Society*, vol. 45, 1884, p. 410.

[4] "Note on the Spontaneous Conversion of Isoprene Into Caoutchouc," by William A. Tilden, *Chemical News*, vol. 65, 1892, p. 265.

Contributed by the Process Industries Division and presented at the Fall Meeting, Louisville, Ky., Oct. 12–15, 1941, of The American Society of Mechanical Engineers.

Chemigum, made and used by the Goodyear Tire & Rubber Co., and *Hycar OR*, previously called Ameripol and Liberty Rubber, which is being sold by the Hycar Chemical Co., are both classed as butadiene rubbers because their major constituent is butadiene. It is understood that the butadiene is polymerized in the presence of another polymerizable material, the composition of which has not been made public.

Perbunan. Also during the year 1940, the Standard Oil Company of New Jersey announced they would manufacture and sell in this country the synthetic rubber, Perbunan, which had previously been imported from Germany, and the Firestone Tire & Rubber Co. also decided to manufacture this product for their own consumption.

Fisher[6] defined synthetic rubber as a (synthetic) substance that can be stretched to at least twice its original length and that, having been stretched, returns approximately to its original length or position in a reasonable time. It is the author's opinion that this is one of the most rational definitions of synthetic rubber that has been published. It will be noted that it makes no reference to chemical composition and it is sufficiently broad to include many types of synthetic materials. If we accept this definition, it is necessary to include a number of nonvulcanizable plastics in a discussion of synthetic rubbers because some of them have sufficient resemblance to rubber to permit their use as a substitute for it within a limited range of temperatures. Outstanding among these are Koroseal and Vinylite, both of which contain substantial amounts of polymerized vinyl chloride. Each has found important applications in insulated wire and some types of coated fabrics. To these may be added polyvinyl alcohol, which has demonstrated its merit for certain types of tubing and gaskets, and Vistanex, polyisobutylene, which may be used as an extender for natural rubber in products which are not submitted to severe mechanical stresses.

Taking into account all of the materials which are commercially available for use in the manufacture of rubber-like products, we find that the rubber industry in this country has many strings in its bow and that, in the event of a stoppage of our crude-rubber imports, we have available many supplements to our rubber supply.

PRODUCTION CAPACITY IN UNITED STATES

At the time Hitler marched into Poland, the du Pont Company was producing neoprene at the rate of about 1500 long tons a year and Thiokol was being produced at the rate of 500 tons a year. Soon thereafter the production of both neoprene and Thiokol was increased and the production of the butadiene types of synthetic rubbers was started in this country. The production of all has increased rapidly and steadily since that time. Table 1 shows the growth of this country's synthetic-rubber production, comparing each year's production with the crude-rubber consumption.

All manufacturers of these synthetic rubbers have additions to their plant facilities under construction, and by the end of 1942 it is expected that there will be capacity in this country for producing about 19,200 long tons a year of neoprene, 10,800 of butadiene rubbers, and 6000 of polysulphide rubbers, all financed by private enterprises. In addition, four synthetic-rubber plants are to be financed by the government and operated by private industry for the account of the government. In them will be made the butadiene-styrene interpolymer and they will have a combined capacity of 40,000 long tons a year. It is also expected that by the end of 1942 there will be capacity for producing about 4800 long tons a year of butyl rubber. Hence, by the end of 1942 we shall have capacity for producing a total of about 80,800 long tons a year of these synthetic rubbers, or about 11 per cent of the estimated crude-rubber consumption for the year 1941.

[6] "Natural and Synthetic Rubbers," by H. L. Fisher, Edgar Marburg Lecture, A.S.T.M., 1941.

TABLE 1 AMERICAN SYNTHETIC-RUBBER PRODUCTION AND CRUDE-RUBBER CONSUMPTION

Year	Neoprene types	Butadiene types	Polysulphide types	Synthetic-rubber production, long tons	Crude-rubber consumption, long tons	Comparison synthetic production to crude-rubber consumption, per cent
1939	1750	None	500	2250	592,000	0.38
1940	2500	60	700	3260	648,500	0.50
1941 (est.)	6300	4000	1400	11,700	726,147[a]	1.61

[a] January to June, inclusive, actual; July to December, inclusive, estimated. Corrected to 100 per cent from estimate of reported coverage (*India Rubber World*, Sept. 1, 1941). July to December, inclusive, estimated on basis of O.P.M. order dated June 21, 1941: July consumption estimated to be 99 per cent of average monthly consumption during twelve months ending March 31, 1941; August, 94 per cent; September, 89 per cent; October, 84 per cent; November, 82 per cent; December, 80 per cent.

At face value, these figures point to a dark picture if the imports of crude rubber into this country should cease, but if we take into consideration all of the factors which may properly be included, the future looks much brighter. In addition to those items which were shown in Table 1 we may take into account the following:

1 The accumulation of a reserve of crude rubber by the Rubber Reserve Corporation.

2 Plants under construction to produce unplasticized polyvinyl chloride equivalent to about 15,000 tons a year of finished product of average plasticizer content.

3 Existing capacity for producing 300,000 long tons a year of reclaimed rubber.

Reclaimed rubber is injected into this discussion because it has been used for a great many years in large quantities as a substitute for crude rubber, and it will have an increasingly important role in carrying out our national policy of crude-rubber conservation. Reclaimed rubber is not substituted for new rubber on a pound-for-pound basis because it contains most of the ingredients with which it was originally compounded, and adjustments are therefore made according to the amount of reclaimed-rubber hydrocarbon which is present. It is used in the production of many articles to impart certain desirable properties which it would otherwise be difficult to obtain. However, its quality is below that of natural rubber, especially for use in articles subjected to abrasion.

If we take into account the accumulation of the crude-rubber reserve, the estimated production of nonvulcanizable but rubber-like plastics, the existing capacity for producing reclaimed rubber, and the aforementioned capacities for producing synthetic rubbers, it appears obvious that the rubber situation will be greatly improved by the end of 1942. Nevertheless, we shall be obliged to dispense with all but the most essential needs if the imports of natural rubber should cease.

The expansion in the production of synthetic rubber as now planned will require serious sacrifice on the part of industry in general to supply the necessary skilled labor, construction materials, and auxiliary services. How fast this expansion takes place depends upon our ability to provide these items without seriously handicapping other equally essential defense industries. In addition to providing materials and chemical equipment to construct polymerization plants, facilities must be found to produce an adequate supply of electricity, steam, water, and other necessary services such as maintenance shops,

plant hospitals, cafeterias, and the like, and, of course, behind all this is the problem of supplying the intermediates of which synthetic rubbers are made. Some of the more important of these are acetylene, butadiene, styrene, acrylonitrile, catalysts for polymerization, emulsifying agents (which are largely made from vegetable oils), and even the common acids and alkalies.

SUPERIOR PROPERTIES, NOT PRICE, WILL DETERMINE PEACETIME USE OF SYNTHETIC RUBBER

There is little prospect that synthetic rubber can be made as cheaply as natural rubber can be grown. There is little chance of competing favorably cost-wise with fertile land, rain, sunshine, and cheap coolie labor. Larger-scale output may result in economies in the manufacture of synthetic rubber, but natural rubber normally will sell for less per pound. It will be recalled that crude rubber has been delivered in New York at a profit at 15 cents a pound and, if competition requires, it can be delivered for 10 cents a pound or less on an out-of-pocket basis. It was delivered in this country for less than 4 cents a pound during the recent general business depression.

The postwar prosperity of the synthetic-rubber industry is largely dependent upon the extent to which new uses are found for its products, and consequently it is especially dependent upon the extent to which mechanical engineers use them in their designs of mechanisms. Already new machines have been designed around synthetic-rubber parts, and still newer developments are believed to be in process which may be all or partly dependent upon synthetic rubber.

The experience now being obtained with synthetic rubbers for direct and indirect defense will have a favorable influence on the postwar expansion of commercial uses. It will acquaint consumers with the advantages which may be obtained by using them and will stimulate their adoption in many new industrial services.

USES OF SYNTHETIC RUBBER

No discussion of synthetic rubbers would be complete without reference to their uses. Although a number of flexible and extensible plastics were mentioned as synthetic rubbers in the foregoing discussion of production capacities, the following discussion will be limited to those synthetic rubbers which are recognized as having physical properties closely related to those of natural rubber.

Synthetic rubbers have been used principally where flexible and resilient products have been required to perform under conditions which would rapidly deteriorate natural rubber. All three classes of the synthetic rubbers which have been used commercially during the last few years, namely, neoprene, Thiokol, and Perbunan, and the more recent members of the butadiene rubber family, Chemigum and Hycar, resist the action of most solvents, but no two of them have the same resistance to all solvents. Also, there is a difference in their ability to withstand the effects of actinic light, particularly if the article undergoes severe mechanical stresses while in service. All of them can be compounded to resist oxidation better than rubber.

Engineers have utilized their special properties in many different types of equipment. A substantial outlet for them has been in hose, packings, and gaskets, molded sealing devices, power-transmission and conveyer belts, protective garments including household and industrial gloves, protective jackets over electrical insulation, and even in the soles and heels of shoes for workmen who must expose them to conditions which rapidly destroy rubber or leather. Synthetic rubber has also found a market in the production of hospital accessories, such as hospital sheeting, oxygen tents, and heating pads, and in innumerable articles used in the home and office. The automotive industry has been one of the largest consumers of articles made from synthetic rubber.

The favorable reception given to products made of synthetic rubber is largely due to their ability to retain their original characteristics after exposure to service conditions which rapidly deteriorate rubber. While they have in some cases original physical properties slightly inferior to those of natural-rubber products, their ability to resist deterioration under severe service conditions more than offsets this deficiency. For example, synthetic compositions usually compare favorably with products made of rubber with respect to tensile strength, but show no outstanding superiority in this property. However, when the composition is exposed to deteriorating influences such as oils, solvents, heat, or sunlight for a period of time, its superiority in retained tensile strength is often sufficient to warrant its use at a higher cost. It is the author's opinion that a high tensile strength before exposure to service conditions is too frequently made the quality criterion of a composition without giving due weight to the ability of the product to retain this property.

Synthetic rubbers may be compounded to produce as wide a range of hardness or stiffness as may be obtained with natural rubber with the exception that it has not been found possible to match the hardness and durability of ebonite with all of them. Nevertheless, products varying from soft printers' rolls to hard solid tires for industrial trucks are in daily production. A general inferiority with respect to stiffening at low temperatures has been prevalent in many synthetic-rubber compositions. However, a new product and recent improvements in compounding methods have made it possible to rectify this deficiency to a great extent.

SYNTHETIC RUBBER FOR AUTOMOBILE TIRES

One seldom discusses the properties of synthetic rubbers, particularly abrasion, resilience, and elasticity, without referring to automobile tires. Street and Ebert[6] have reported that tire treads made with two butadiene rubbers, namely butadiene-styrene and butadiene-acrylonitrile copolymers, or with neoprene, wore equally as well as rubber treads on passenger-car tires. Subsequent work has demonstrated that truck-tire treads made from certain of these synthetic rubbers may be definitely more durable than those made from natural rubber under severe conditions of service such as heavy-duty tires which are used on slow-speed equipment operated in stone quarries, in strip mines, and in general on unimproved roads where the tires are subjected to unusually severe abrasive action, cutting, and chipping. The solvent-resisting synthetic rubbers, neoprene and the copolymer of butadiene-acrylonitrile, should produce vastly more durable treads than natural rubber on asphalt-truck tires which are operated in road-building work or on tires used in the oil fields where they may frequently come in contact with crude oil.

It is generally agreed that the butadiene-styrene copolymer makes a reasonably satisfactory tire tread for passenger-car tires, although perhaps not for the high-speed bus and truck tires in which the development of heat in service is a more important consideration.

Less progress has been made with the substitution of synthetic rubber for natural rubber in carcasses of automobile tires. Until very recently no synthetic-rubber compositions were produced that were so elastic as those which could be made from natural rubber or which showed as low energy loss due to mechanical hysteresis. All of them generated more heat under rapid deformation. This difference between synthetic and

[6] "The Use of Synthetic Rubber in the Automotive Industry From the Viewpoint of the Rubber Technologist," by J. N. Street and H. L. Ebert, *Rubber Chemistry and Technology*, vol. 14, 1941, p. 211.

natural rubbers has been lessened by improved compounding methods, and there is now some evidence that certain types of synthetic rubbers may be developed which will be superior to natural rubber in this respect. Improved service in the carcasses of truck tires operated in extremely high temperatures will be obtained when compositions having low energy loss because of mechanical hysteresis are developed with synthetic rubbers which are inherently resistant to deterioration by heat. The requirements for passenger-tire carcasses are less severe, and the experimental evidence at hand indicates that the butadiene-styrene interpolymer will be satisfactory for this purpose. The four government-financed synthetic-rubber plants will produce this butadiene-styrene copolymer chiefly because it appears to be the least expensive synthetic rubber which may be substituted for natural rubber in the manufacture of tires. It is believed that this substitution could be made without undue hardship on the part of the motorist if he would keep his car in good mechanical condition and, among other good driving practices, avoid speeding, especially around curves. It is the author's opinion that if a serious shortage of natural rubber should occur within the near future, the carcass rubber in passenger tires would be made largely from reclaimed rubber and synthetic rubber would be used chiefly in treads.

MISCELLANEOUS APPLICATIONS OF SYNTHETIC RUBBER

There is a difference among the synthetic rubbers with respect to their performance under prolonged heat, especially in articles which are also under continued mechanical stress. Some will deform and fail rapidly. Others will harden slowly and become less resilient instead of softening and deteriorating rapidly, as is the case with natural rubber. The ability of certain synthetic rubbers to withstand heat has resulted in their replacement of natural rubber for numerous industrial uses, such as gaskets, conveyer-belt covers, linings for hot gas vents, and the like, where high temperatures are encountered. With the improvements in elasticity and with better heat resistance, it is probable that synthetic rubbers will find wide application for isolating vibration in many mechanisms of the future.

The diffusion of gases through synthetic rubbers and through most of the elastic plastics as well is at a much lower rate than through natural rubber, which makes them useful not only in the construction of military balloons and in protective clothing, but also in the construction of diaphragms for industrial apparatus.

The polymers of chloroprene and of vinyl chloride are flame-resistant and, when properly compounded, do not continue to burn after the flame is removed. They have been substituted for rubber in compositions where this property is desired as, for example, in the insulation of electric wire used in mines and on ships.

A new type of neoprene has been developed that can be plasticized to an exceptionally soft consistency. It may be used to produce resilient calking compositions or flexible protective coatings which can be applied to a wide variety of surfaces by trowel or brush. Experimental applications have given satisfactory service as linings for certain chemical equipment, coverings for agitators, and coatings on fan blades and on the inside of ducts used in ventilators for corrosive gases. Another interesting application has been the preparation of a plastic but vulcanizable composition for stuffing a wood mold to produce cheap rubber models of experimental machine parts. Future applied research with this product may produce compositions suitable for injection molding.

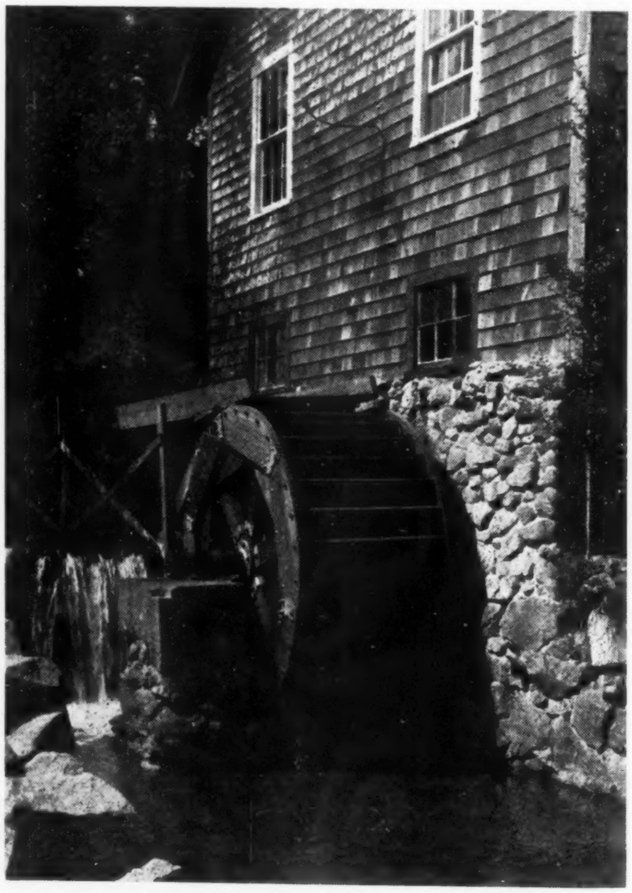
The use of synthetic-rubber lattices has increased steadily and, like the solid polymers, they are being used for numerous purposes where they are more durable than the natural product. It is probable that the synthetic lattices which are now available and which are being developed in laboratories engaged in this field of research can be used to supplement natural-rubber latex if it should become necessary to do so.

Many improvements have been made in the compounding and processing of natural rubber, adding vastly to its durability and utility, but rubber itself has not been changed. On the other hand, the quality of synthetic rubbers has been improved and new types have been developed. The synthetic rubbers of the future will undoubtedly be superior to those of today.

It is important that the design engineer recognize the fact that there are inherent differences among the several synthetic rubbers and that the properties of each can be modified greatly by compounding and processing. He certainly should not attempt to interpret the performance of all synthetic rubbers, even those within a given class, by the performance of any particular product sample he may have on hand. It will require close cooperation between the engineer and his producer of rubber goods to keep abreast of the new developments in this industry in order to make the most efficient and extensive use of synthetic rubber.

ACKNOWLEDGMENT

Several months after the author was asked to give this paper, E. R. Bridgwater gave a paper before the American Chemical Society on "The Present Status of Synthetic Rubber." The author is pleased to acknowledge his indebtedness to Mr. Bridgwater for the data on synthetic-rubber production capacity.



OLD MILL

(Photograph taken by Leonard Ochtman, Jr., and shown at the Sixth Annual Photographic Exhibit held during the A.S.M.E. Annual Meeting, Dec. 1–5, 1941, New York, N. Y.)

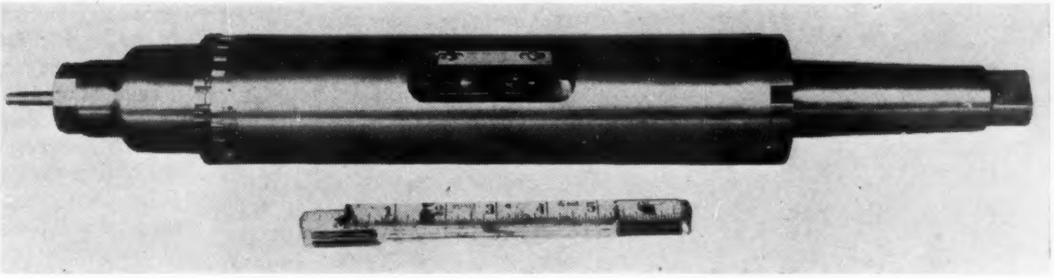


FIG. 1 RIFLING HEAD FOR 3-IN. GUN BARRELS

BROACHING *of* RIFLING *in* CANNON

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THE various methods of machining the rifling grooves in cannon have been a natural growth over a period of years. These methods vary with the length and diameter of the bore. Since 1918, the Springfield Armory and Rock Island Arsenal have carried on tests, within the limit of funds available, for improving methods of rifling small-arms weapons, and the Watervliet Arsenal, for rifling cannon. At present, all guns below 0.6 in. bore are classified as small-arms weapons and all above as cannon. This discussion is confined primarily to cannon.

STANDARD METHODS OF MACHINING RIFLING GROOVES

The two methods which have been standards for many years are the single-hook cutter and the multitool adjustable rifling head. The former was applied mostly to small arms and to cannon from 0.8 to 1.5 in. bore. The latter was used for all calibers above 1.5 in.

Single-Hook Cutter. The hook cutter is a pull-type tool mounted in a head the diameter of which is between 0.001 and 0.0005 in. smaller than the minimum bore size. It is fed out for depth of cut by hand by means of a micrometer adjustment and a wedge on which the cutter rides. On the return stroke, the cutter springs back out of the way in order not to drag against the bore, or is pulled back by use of a double wedge. The twist is imparted by the usual grooved rifling bar. There is an automatic indexing head which shifts the cutter into position at the end of each stroke for the next groove to be cut. The advantages credited to this type are as follows:

1 Simplicity of cutter manufacture.
2 Low cost of upkeep.

The disadvantages include:

1 Length of time required to complete a barrel.
2 Number of rifling machines required.
3 Danger of taking cuts too heavy because of the hand feed.

Adjustable Cutter Head. The adjustable cutter head is of the push type known as the Watervliet head and also as the White head. It is mounted by means of a taper shank at the end of a grooved rifling bar. It consists of a cast-iron or bronze sleeve mounted on a steel body. The sleeve is slightly smaller than the minimum bore size. Inside the body is a cone with tee slots for mounting the individual cutters. Longitudinal movement of the cone by means of a micrometer screw and push rod expands or contracts the cutters radially to increase the depth of cut. Because of space limitations, it is never possible to provide cutters for more than one half the number of grooves to be cut and, on the smaller sizes, one third or one quarter of the number of grooves. For this reason, it is necessary to provide a means for indexing the head. Cutters must be individually numbered and fitted to similarly numbered slots in the rifling head. It is important that there be no side or end play which causes chatter or scoring of the side walls of the rifling. The normal depth of cut is 0.001 to 0.0015 in. until near to full depth of the groove when the cut is diminished to 0.0005 in. to obtain the final smooth finish. Cuts finer than 0.0005 in. are to be avoided with any method of rifling, because of the danger of riding over the surface without cutting. When this happens, and it does happen, the next pass of the tool takes a double cut which may break the tool or leave an unsatisfactory finish. In the larger cannon, a set of roughing or so-called breakdown cutters is used. This set is followed by a set of finishing cutters.

In practice the operator sets his cutters out by means of the micrometer screw to take the proper depth of cut. He then starts the machine, pushing the rifling head through the bore. The push rod on the cutter cone contacts a stop at the end of the cutting stroke and contracts the cutters so they do not drag on the return stroke. He then withdraws the head by reversing the machine and resets the cutters for the next cut. When one set of grooves has been finished to proper size, he indexes the entire rifling head into position for the next set.

The advantages of this type are as follows:

1 Ability to cut uniform or increasing twist of rifling.
2 Change of shape of grooves only requires new cutters.
3 Cost of cutters is not excessive.

The disadvantages are:

Contributed by the Machine Shop Practice Division and presented at the Annual Meeting, New York, N. Y., December 1–5, 1941, of The American Society of Mechanical Engineers.

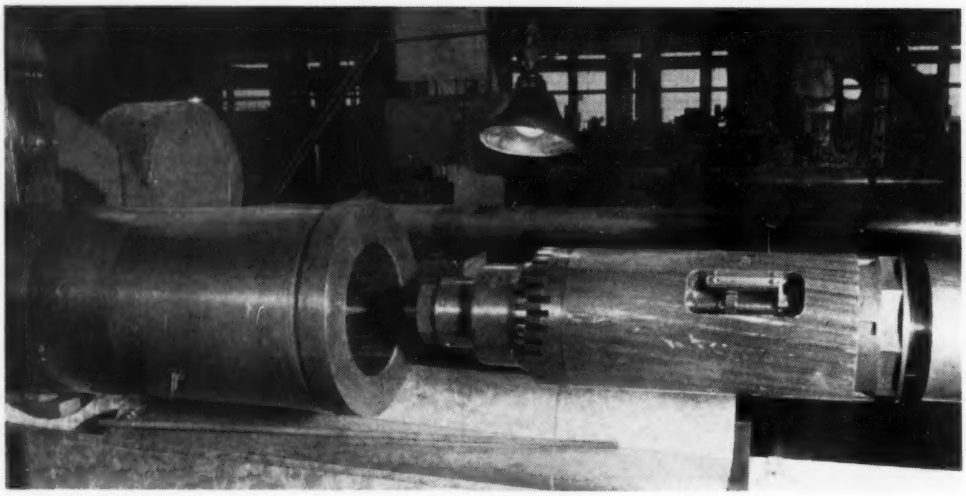

FIG. 2 AN 8-IN. RIFLING HEAD

1 Requirement for skilled operators and careful adjustment of cutters in rifling head.

2 Operating time is slow.

3 Hand feed is dependent upon skill of operator.

4 Because of number of passes required, cutters often must be ground, or at least stoned, before one gun can be completed.

DISK-BROACH METHOD

The disk-broach method is one of the most modern methods now in use. It was first applied to any extent in 1918, for the manufacture of 75-mm and 155-mm French guns. However, after the experience gained during the war, the shape of rifling grooves was materially altered in order to improve accuracy life. The old radial grooves were replaced by grooves of much greater depth having straight side walls which were much more difficult to machine. Disk broaches for cutting the new type of rifling were developed at the Watervliet Arsenal. All disk broaches now manufactured were taken from the Watervliet drawings.

In order to reduce cost and also because the number of guns being manufactured was greatest, the first broaches were developed for the 37-mm (1.457-in.) bore. It required nearly two years to perfect them so that they were satisfactory for production.

With successful completion of the 37-mm size, the 75-mm, 3-in., 105-mm, 90-mm, and 155-mm sizes followed rapidly. The 8-in. size is now in process of development and will be discussed later. It is probable that no larger sizes will be attempted because the quantity of guns of larger size manufactured is insufficient to justify the expense. Also, the 8-in. size approaches the practical limit for this method of rifling. This method has been thoroughly tested and is positively safe to use provided proper technique is followed.

DETAILS OF THE DISK BROACH

The standard type of grooved rifling bar is used, with the rifling head mounted by means of a taper shank. The rifling head is a solid steel body drilled for passage of coolant and with a cast-iron or bronze sleeve for proper bearing surface in the bore of the gun. The disk cutters are mounted at the front end of the head on a closely fitted pilot and are driven by means of a key inserted in the head. A nut is used to steady the cutter on the head to avoid chatter. In certain guns where the width of the land is narrow and the cutting pressure high, it has been found necessary to insert carbide bearing strips to prevent cutting or excessive wear of the bearing sleeve.

With the exception of the 20-mm size, all of the disk broaches are designed to cut all the grooves at once. In the 20-mm, the bore is so small in proportion to the length of tube that the rifling bar buckles under pressure of the cut if all grooves are cut at once. Therefore, it is necessary to cut but three grooves at one time and index the head in the same manner as with the adjustable cutter head. The disk-broach method is not recommended for the 20-mm guns.

The broaches are made from solid bars of high-speed steel up to and including 6 in. diam. The 8-in-diam broaches now being manufactured for test are to be made up of sectors bolted on hardened steel disks. If successful, this may also be used for 6 in. diam in the future.

The number of disks required varies from 28 for the 37-mm gun to 56 for the 155-mm gun. The maximum depth of cut is 0.0015 in., and the minimum for finishing, 0.0005 in. All disks are cut to the full width of the groove. A special cutter, with a 45-deg edge, is provided to remove the burr from the corners of the lands, after the grooves have been cut to the depth of the filet radius. Special fixtures are required for manufacturing the disks in order to insure interchangeability and to maintain accurate alignment, in order to avoid digging in or tearing the side walls of the grooves.

In arsenal practice, the side clearance angle is designed to clear about 6 deg on either side of the groove. Because of the twist of rifling, this means a different angle on either side. The top clearance angle is 1.50 deg. This has been worked out by experience and applies to all types of rifling cutters. Certain

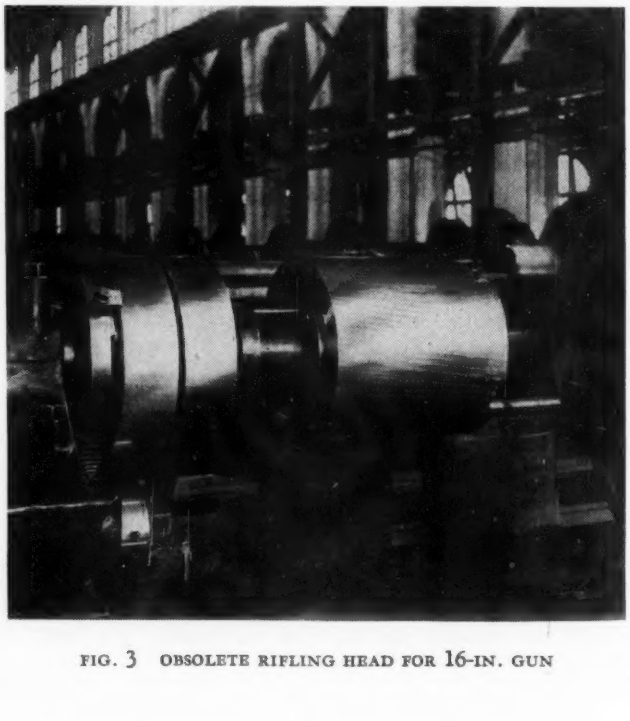

FIG. 3 OBSOLETE RIFLING HEAD FOR 16-IN. GUN

broach manufacturers, making these disks today, leave no side clearance, but grind the broaches with the same twist as the rifling. This has the advantage of longer broach life before the cutters become too narrow, but is perhaps more likely to cause roughness on the side walls of the groove.

PRACTICAL OPERATING NOTES

Except for the 155-mm size, no front pilot is used to guide the rifling head into the bore. Instead, the forward steady rest is placed as close to the muzzle of the gun as assembly of the disks and locking nut will permit. Thus the head is held rigidly until well supported by the bore proper. The use of a pilot is to be avoided whenever possible because it restricts flow of coolant and confines the chips. It also complicates assembly and removal of disks during the rifling operation.

This method has been developed for pushing the cutters although in principle it would appear that a pull cut would be more desirable. Actually the pull cutting head is difficult to design to permit ready assembly of disks. A chip clearance must be provided which requires a small-diameter pull bar in front of the cutter. This lacks sufficient rigidity to hold the cutter concentric with the bore. Possibly, a rear pilot would correct this condition, but at best the design is complicated by comparison.

Coolant should be fed under at least 500 psi pressure. The flow should be directed behind each cutting edge by properly directed holes drilled radially to the center. Coolant is fed through the rifling bar. One manufacturer feeds coolant both at the front and rear of the cutters. Feeding to the front only is not successful because chips prevent the coolant from penetrating to the cutting edges.

Properly designed cutters may be stepped down when worn and in case of accident any cutter in the set can be readily replaced. If for any reason the head gets stuck in the bore, it is usually possible to unscrew the locking nut and withdraw the head, leaving the cutter in the bore. The cutter can then be pushed out backward or broken and the gun barrel saved. The usual practice is to provide two boxes for cutters, keeping one

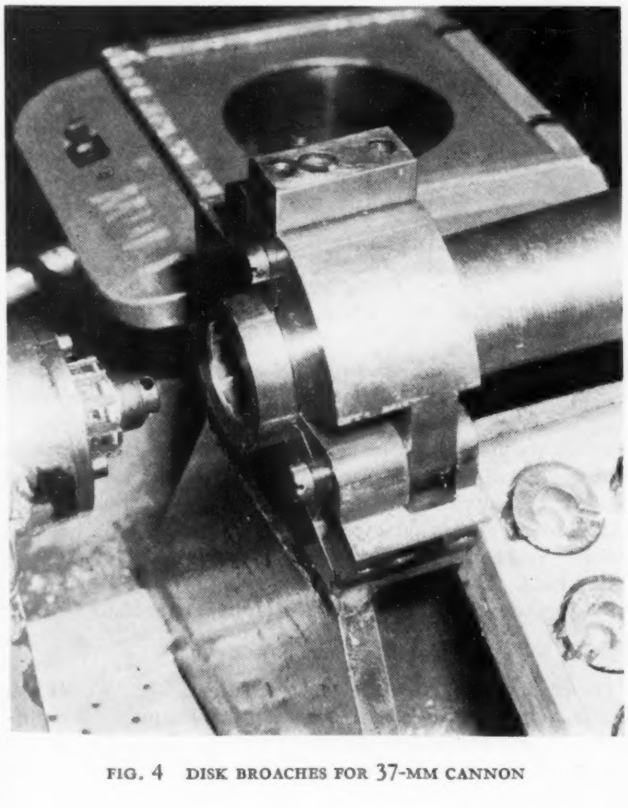

FIG. 4 DISK BROACHES FOR 37-MM CANNON

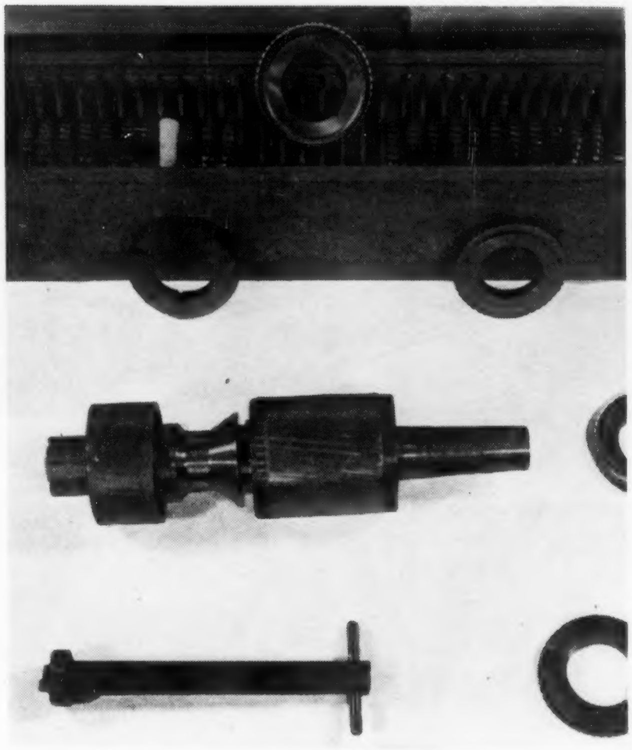

FIG. 5 DISK BROACHES FOR 155-MM CANNON

at either end of the machine, in order to avoid the possibility of assembling the wrong one to the rifling head.

The particular advantages of this method are as follows:

1 Substantial time saving.

2 Elimination of requirement for skilled mechanics.

3 Practical elimination of the "human element," since the depth of cut is automatically governed.

4 Reduction of the possibility of spoilage.

The disadvantages include:

1 Necessity of providing fixtures to insure interchangeability of cutters.

2 Danger of using the wrong cutter.

PULL-BAR BROACH THE LATEST DEVELOPMENT

The most modern development of rifling methods is that of the pull-bar broach. This has been strictly a commercial development with the Watervliet Arsenal lending technical advice and assistance. The Arsenal has never attempted to manufacture this type of equipment. The companies which have worked on this method include the American Broach & Machine Company, Ann Arbor, Mich.; the Illinois Tool Works, Chicago, Ill.; and the Lapointe Machine Tool Company, Hudson, Mass. Each of these companies has approached this problem independently, and as a result the method of machining varies according to individual engineering practice.

To date this method has been tested for bore sizes from 0.22 caliber up to 3 in. Those which are in actual use, or give most promise of success, are for the 0.50-caliber machine gun, the 20-mm machine cannon, and the 37-mm gun. It is the author's personal belief that the practical limit for this method is determined by the bore diameter and length of barrel, and will probably include the 40-mm gun. Beyond this size, the disk-broach method appears at present to be most suitable. Above 8-in. gun calibers, the adjustable cutter head is to be preferred.

The Lapointe Machine Tool Company has a special six-

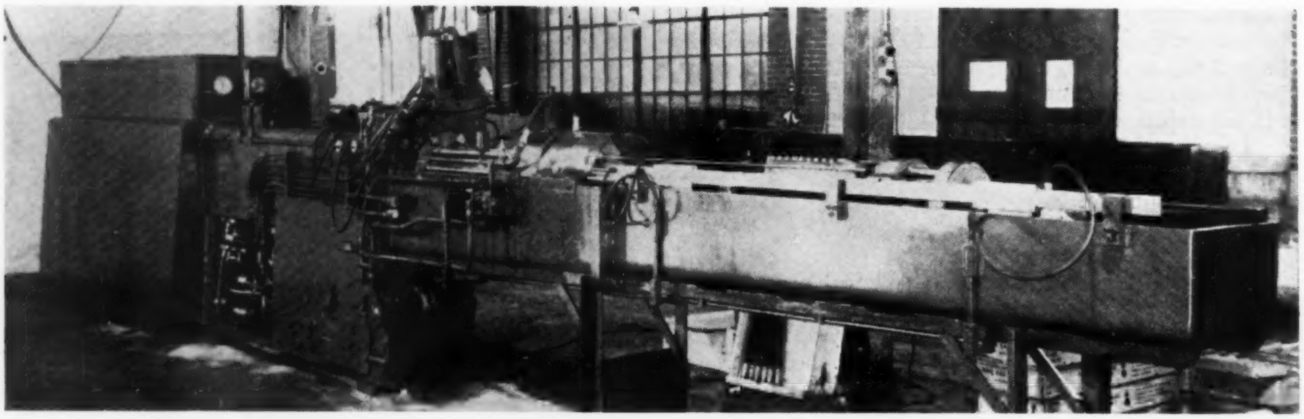

FIG. 6 LAPOINTE 0.50-CALIBER BROACHING MACHINE

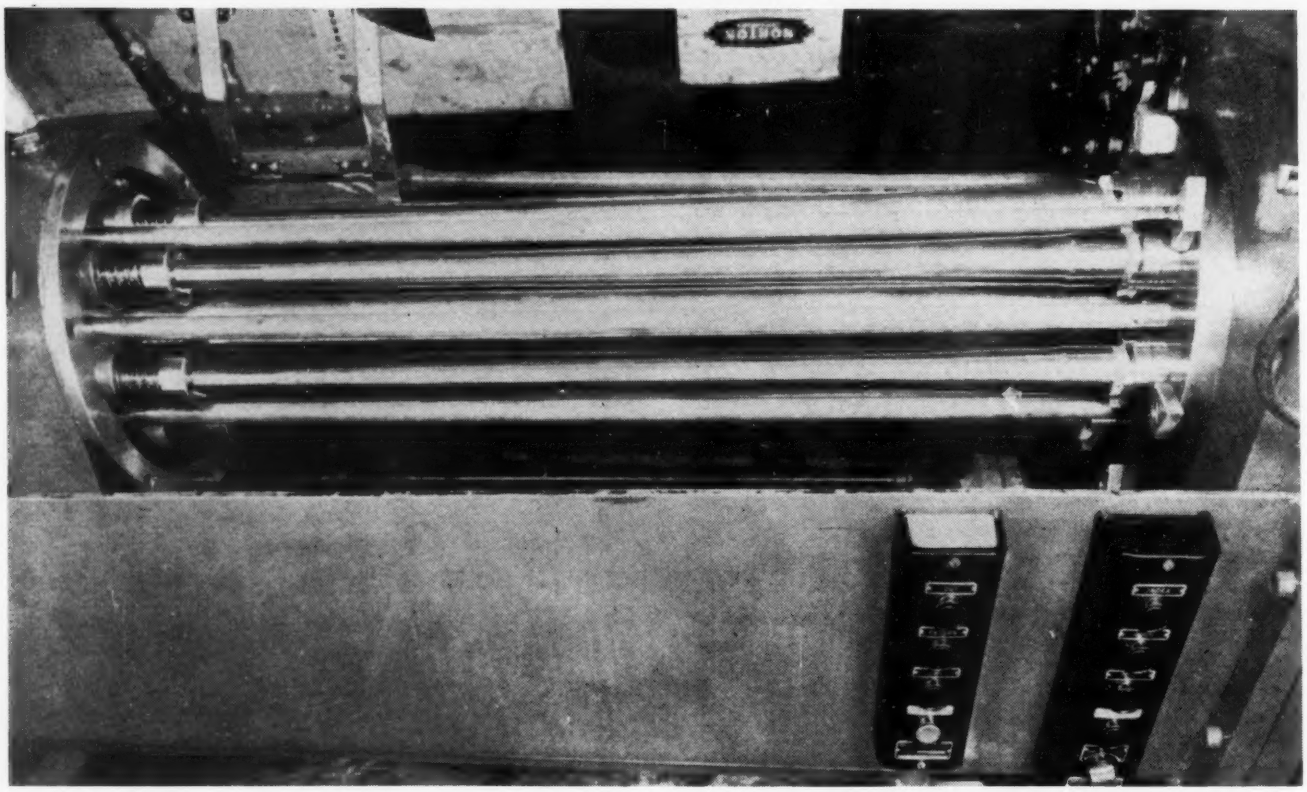

FIG. 7 LAPOINTE MACHINE, SHOWING METHOD OF SUPPLYING COOLANT TO 0.50-CALIBER BROACHES

station machine for 0.50-caliber machine guns, and a single-station machine for the 20-mm or 37-mm guns. The rifling principle is the same except that the six-station fixture permits one loading station and a set of five broaches to work simultaneously. Thus a gun is completed for each stroke of the machine. A grooved rifling bar is used to guide the broaches through a gear train.

RIFLING THE 37-MM CANNON

In the 37-mm setup, one broach is pulled at a time. The broach floats on a frictionless bearing, developing its own twist. A pilot is provided for centering in the bore and for locating in the grooves already cut. There are eight broaches in the set. No. 1 cuts no grooves but sizes the bore by removing 0.005 in. from the diameter and leaves 0.005 in. for the finish broach. Nos. 2 to 6 cut the grooves. Each broach removes 0.005 in. in depth, and each cuts a groove 0.005 in. narrower than its predecessor. No. 6 finishes to within 0.002 in. of the finish depth. No. 7 finishes the grooves to full width and depth. No. 8 removes the final 0.005 in. from the top of the lands, leaving tool marks following the twist. If the cannon manufacturer desires to start with a bore, honed to finish size, the Nos. 1, 2, and 8 broaches are eliminated and a special No. 1 broach is provided. This company estimates 20 minutes as the floor-to-floor rifling time, with a tool wear of approximately 100 guns per grind. Material up to 320 Brinell can be broached.

BROACHING THE 20-MM GUN

For broaching the 20-mm gun, the Illinois Tool Works uses four broaches. No. 1 is used for sizing the bore only. Broaches Nos. 2, 3, and 4 complete the rifling and are designed to cut the full width of the grooves until finish depth is reached. These

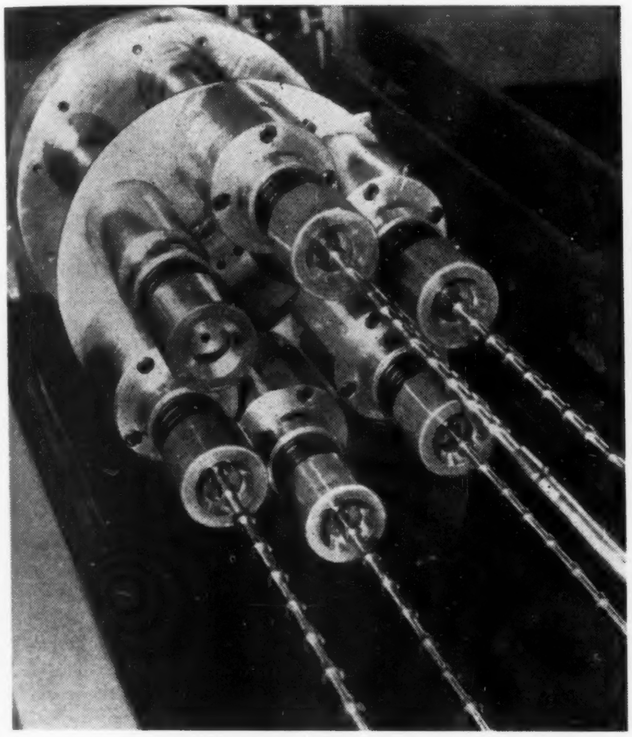

FIG. 8 LAPOINTE MACHINE, SHOWING BARREL-HOLDING FIXTURE AND INDEXING HEAD

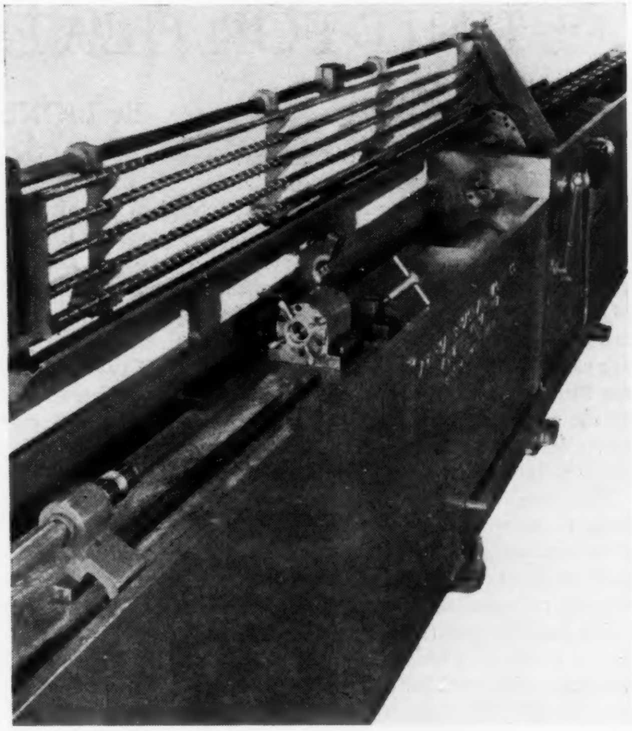

FIG. 9 AMERICAN BROACH & MACHINE COMPANY MACHINE FOR 20-MM BARRELS

broaches have two pilots at the pull end, the first for locating in the grooves already cut, and the second for centering with the bore. This is an excellent idea and greatly facilitates entering the broach into the bore to start the cut. A grooved rifling bar must be used with this method and is cut from the same master as the broaches. This is extremely important, and prospective contractors should be warned to use only broaches cut from the same master as the rifling bar.

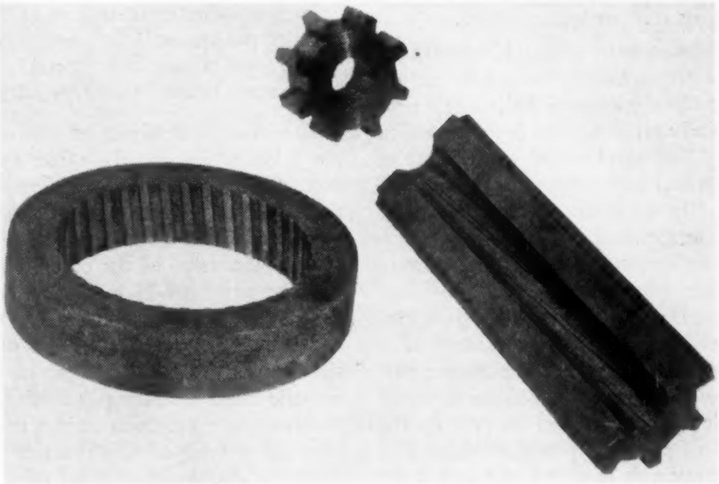

FIG. 10 SECTION OF 105-MM AND 20-MM BARRELS BROACHED BY AMERICAN BROACH & MACHINE COMPANY

The American Broach & Machine Company also uses a set consisting of four broaches. These are designed to start with a honed bore and the No. 1 broach cuts one quarter of the width of the groove to within a few ten thousandths of finish depth. Nos. 2 and 3 broaches each cut an additional quarter of the width of the groove to the same depth as No. 1. No. 4 removes the final quarter of the groove width and finishes them to full depth. A rifling bar is used and a single pilot for locating in the grooves and centering. The machine is of standard hydraulic pull type.

The advantages of this type broach are as follows:

1 The material saving in production time.

2 Saving in number of machines required.

3 Saving in floor space.

The disadvantages are:

1 Inability to cut increasing-twist rifling.

2 Danger of tearing side wall of groove if angle of twist is not correct.

3 Danger of pilot sticking in bore.

SUMMARY

As a rapid recapitulation, none of the methods discussed is new in principle. However, the disk-broaching and pull-bar-broaching methods have been materially improved and modernized. The single-hook cutter with automatic indexing is still widely used although slower than pull-bar broaching.

Pull-bar broaching has yet to stand the test of time, but it should eventually prove to be the most efficient method for bore diameters from 0.5 to 2 in. The practicability of disk broaches has been definitely proved. They are very satisfactory for bore diameters from 1.5 to 6 in. and probably 8 in. The adjustable cutter head is the most satisfactory for bores larger than 8 in. Future developments, however, may lead to entirely different conclusions.

UNIT FOR HEAT-TRANSFER RATES

By LIONEL S. MARKS

GORDON MC KAY PROFESSOR OF MECHANICAL ENGINEERING, EMERITUS, HARVARD UNIVERSITY

THE following discussion deals with the units in which the time rate of energy flow should preferably be stated. Two such units are in common use, the horsepower and the kilowatt, but no unit is available for heat flow per unit of time. Many composite heat-flow units are in general use, such as calories per second or Btu per hour. The calories may be 15-deg calories, 20-deg calories, mean calories, or IT calories, and the Btu are equally diverse. Similarly, the time element may be the second, minute, hour, day, or other interval. A cursory examination of the literature discloses some twenty composite units in recent use for heat-transfer rates.

This condition imposes unnecessary hardship on one who seeks to know the heat-transfer coefficient to employ under given circumstances. The values which he will find in various books and other publications are not directly comparable until reduced to some common unit. Moreover, the current confusion leads frequently to error through an inaccurate assumption as to the time unit. It appears desirable to establish some common unit in which to state the results of all heat-flow investigations. This would not debar an investigator from publishing his results in the particular units which he chances to prefer or which are common in his particular corner of the heat-transfer field. It demands only that in addition to the units that he prefers he should state his final results in the common unit. To accomplish this, all that is necessary is to multiply his results by a conversion factor.

In seeking the desirable common unit, it should be realized that there is nothing logical about either the calorie or the Btu. These are based on the Centigrade and Fahrenheit temperature scales, which are entirely arbitrary and between which there is nothing to choose. The mechanical equivalents of these heat units can be determined experimentally but the experimental values are necessarily uncertain. A great step in advance was taken by the International Steam Tables Conference of 1929 in abandoning the definition of the heat unit in terms of the properties of water.

The fundamental energy unit is a work unit (ft-lb, dyne-cm, etc.). The measurement of the flow of electrical energy is in work units, since the watt is defined as 10^7 dyne-cm per sec. The International Steam Tables Conference defined the heat unit in terms of the watt and its definition has been adopted by the A.S.M.E. This is a reversal of previous practice which had based the heat unit on the properties of water through some stated temperature range and had attempted to ascertain the work equivalent of that amount of heat by careful experiment. The IT gram-calorie (International Steam Tables calorie) is defined as 1/860 international watthours. As a Btu is equal to 251.996 calories, the Btu is equal to 0.293 international watthours. The international watthour is the unit actually used by electrical engineers and is 1.0003 times the absolute watthour, a difference too small to be of any practical significance. The absolute watt is defined as 10^7 dyne-cm per sec, which is equal to 0.737562 ft-lb per sec; the international watt is 0.73778 ft-lb per sec. The A.S.M.E. Btu is consequently equal to $0.293 \times 0.73778 \times 3600 = 778.26$ ft-lb. This value is practically identical with the experimentally determined values of the mechanical equivalent of the old Btu and was selected for that reason. It is the unit employed in the Keenan and Keyes steam tables, now accepted as standard by the A.S.M.E. The mean calorie (0–100 C), frequently employed hitherto, is approximately 1.001 IT calories, which makes the corresponding mean Btu equal to 779 ft-lb.

In view of the foregoing facts, there would appear to be no valid argument for the retention of the calorie or Btu in the statement of heat-flow rates unless they possess some special convenience. Exactly the opposite is the case, since there does not exist any heat-flow-rate unit, and their retention results in the multiplicity of composite units noted earlier.

As between the two existing energy-flow-rate units, the horsepower and the kilowatt, the choice must certainly go to the kilowatt, since the horsepower would not be acceptable to those using metric units and, furthermore, the horsepower has been in process of disappearance for a number of years.

The watt, with its multiples and submultiples (kilowatt, 10^3; megawatt, 10^6; milliwatt, 10^{-3}; etc.) is the logical and convenient unit for stating energy flow rates. Its use will simplify the statement of heat transfer; for example, a conductance of x Btu per sq ft per sec becomes y watts per sq ft. The conversion from any of the older composite units to watts is made by a simple multiplication by a conversion factor. The values of these conversion factors are as follows, the calorie being the IT calorie and the Btu, the A.S.M.E. Btu:

1 kilocalorie per second	=	4.186 kilowatts
1 kilocalorie per minute	=	69.78 watts
1 kilocalorie per hour	=	1.163 watts
1 Btu per second	=	1.055 kilowatts
1 Btu per minute	=	17.58 watts
1 Btu per hour	=	0.293 watt

The Main Committee on Power Test Codes of the A.S.M.E. has taken action in this matter by adopting the watt (with its multiples and submultiples) as the preferred unit in stating heat-transfer rates and is drawing the attention of its individual committees and of other interested groups to this unit. It is not the intention of the committee to ask any writer to abandon the unit to which he is accustomed. It is proposed only that in addition to such unit he will present his heat-transfer data in the preferred units—in parentheses or otherwise. By this procedure, all values can be immediately compared without the labor and the possibility of error involved in conversion to some common unit. It seems highly probable that after a few years of this practice the composite units will generally be abandoned in favor of the common unit.

The use of the watt in the statement of heat-transfer coefficients, while unusual in engineering literature, is by no means novel. The International Critical Tables, the most comprehensive repository of physical data, is not quite consistent but uses the watt more than any other unit. A large number of investigators in the field of heat transfer use the electric current as the source of heat, measure the heat transferred in watts, and, in many cases, report their results in the same unit. Furthermore, the watt in the guise of the kilowatthour is in process of becoming our best-known energy unit since householders are paying monthly bills for something so labeled.

The foregoing discussion excludes entirely the further questions arising in connection with heat-transfer problems as to the standardization of surface (per sq ft, per sq cm, etc.) and of temperature gradient (deg C, or deg F per ft, per cm, etc.), since the time does not appear ripe at present for any action looking toward their standardization.

PHYSICAL PROPERTIES *of* BRASS CARTRIDGE CASES

By R. S. PRATT

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THE ultimate success of the breech-loading gun was dependent on the invention of a suitable device to act as a gas seal at the breech and as a container to carry the explosive charge and the cartridge. The first attempts were made with iron but cases of this material stuck in the breech or split badly and leaked gas in firing. These failures were apparently due to the inability of the iron to withstand the necessary elastic deformation. In 1847 Houiller, in France, produced a copper case in which the ignition or primer charge was held in the rim of the case. Such cases were satisfactory for smaller-caliber guns but were very sensitive in the larger calibers and subject to premature discharge. In 1870 General Berdan of the U. S. Army invented the center-fire priming device using a brass shell as the container. The brass case invented by General Berdan is almost identical in principle with the present brass cartridge cases. The use of brass was essential in Berdan's case because of its ability to be fabricated into the desired shape particularly at the primer location and its ability to withstand deformation in firing without permanent change in shape. It is not unusual for the larger cases to be reloaded and fired as many as 10 or 15 times without loss of its desirable characteristics.

FUNCTION OF THE CARTRIDGE CASE

The purpose of the cartridge case is to provide a means of igniting the charge and a means of obturation, that is, preventing the escape of gas from the explosive charge. The first purpose is largely mechanical. In the center of the case head an opening is made to hold a primer. The primer is ignited by the blow of the firing pin. The metal around the primer hole must be sufficiently hard and elastic enough to make sure there is no loosening of the primer and no gas leakage at the primer hole due to the pressure developed in firing.

The wall of the case must be elastic enough to expand under pressure and make a tight seal against the wall of the gun. The pressure developed by the propellent charge is sufficient to burst any case unless it is properly supported by the breech wall. As a result, the clearance between the case and breech wall must be carefully controlled so that a great portion of the strain is taken up by the steel of the breech wall. The relatively low modulus of elasticity of brass combined with its fairly high range of elastic action is the reason for its successful use in a cartridge case. The low modulus permits the quick expansion of the case to the breech wall and subsequent deformation of the case controlled by the deformation of the steel. Its elastic limit is sufficiently high to permit this deformation to take place without permanent set and therefore the case returns to its normal size when the pressure drops. These requirements are necessary to produce the gas seal and the easy removal of the case after firing.

Another factor which seems to enter into the problem is the relatively high-thermal conductivity of the cartridge brass. A great deal of heat is developed by the combustion of the charge and it seems probable that the dissipation of this heat through the brass case wall is sufficient to reduce the net expansion following the firing. A case of lower-thermal conductivity might attain such temperatures as to prevent its rapid removal from the breech and might even result in softening of the case wall. It is apparent that the substitution of other case materials for brass is dependent on several factors which are difficult to control so as to meet the requirements. Such substitution, therefore, is a matter requiring a great deal of study and experimentation.

CHANGES IN MANUFACTURING PROCESS

The original center-fire cartridge case was made of yellow brass and therefore contained about two parts copper and one part zinc. The present cartridge brass is of the same nominal composition, namely, 70 per cent copper and 30 per cent zinc, but its purity is so much greater that its mechanical properties and ability to withstand deformation are much improved. Until as recently as five or six years ago all cartridge brass had been processed entirely by cold-working operations. The spelter or zinc available up to that time contained quite appreciable quantities of lead, cadmium, and iron as impurities. When zinc of high purity was made available it was found that cartridge brass made from such zinc was capable of hot-working without difficulty. Subsequent development of heavy hot-rolling mill and casting equipment suitable for the production of large-size bars made hot-rolling the natural procedure for the initial breaking-down operations. The greater purity of the brass which has made possible these changes in mill operations has also made possible a decreased number of cold-drawing operations in the production of the case.

Modern practice in the production of cartridge brass starts with the casting of bars 500 lb to 1000 lb in weight which are broken down by hot-rolling. The method by which the final gage is reached will depend on the particular case which is to be made. In some cases the rolled bar will be machined to size, in others a cold-rolling operation will be made, followed by annealing to produce the specified grain size for cupping. The rolled bars are then blanked to produce disks of the proper diameter.

The disks are cupped by forcing the circular blanks through a die of smaller diameter and constricting the circumference of the blank around the punch. In the last World War the case for the 75-mm field gun was made by cupping a circular blank and a series of five or six redrawing operations. The same case is made today in only three draws which results in a considerable saving of time and consequent increase in production as well as a decrease in capital investment for press equipment. This improvement is due to the improved purity of the alloy used as well as more powerful and accurate press construction. The same factors have made it possible to produce cases for some of the larger and more powerful guns which would not have been economically possible twenty years ago.

In addition to the reduction in the number of redrawing op-

Contributed by the Metals Engineering Division and presented at the Annual Meeting, New York, N. Y., December 1–5, 1941, of The American Society of Mechanical Engineers.

erations improvements have also been made in the finishing operations such as heading the base, finish-machining of the base, and the local mouth-annealing and relief-annealing operations. The improvement in heading has been due largely to increased press capacity and improved die steel so that full advantage may be taken of the plasticity of the brass. The machining operations have been speeded up by more modern machine equipment, cutting tools, and lubricants. In order to take advantage of the improved equipment it has been necessary to provide annealing equipment in which the properties of the annealed brass may be exactly controlled. Pyrometric control of annealing equipment is taken as a matter of course today whereas twenty-five years ago it was hardly beyond the experimental state. Taper and mouth annealing are almost entirely done by automatically controlled salt-bath anneals. Relief annealing, which is an extremely sensitive anneal at temperatures in which heat transfer is rather slow, is now done in forced-convection furnaces or salt baths in which the time of exposure can be appreciably reduced and the results more accurately controlled.

Not the least of the steps taken to increase production has been the application of modern production methods for the inspection of finished cases. All the dimensions of every cartridge case must be controlled within very narrow tolerances and the checking of each dimension is a lengthy process.

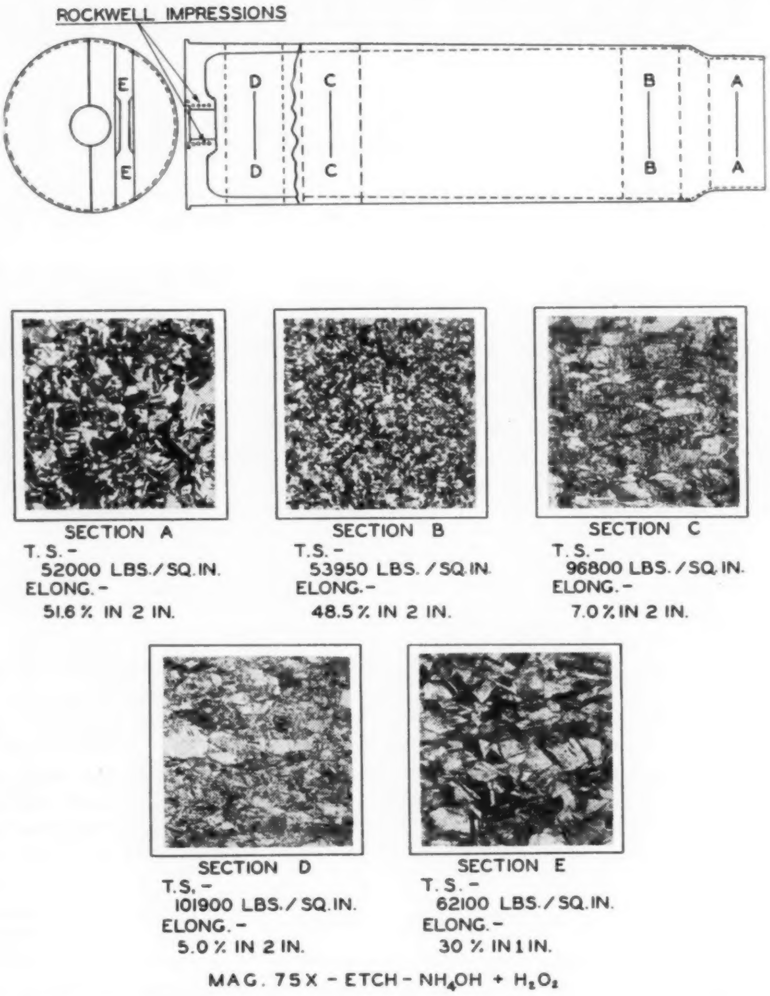
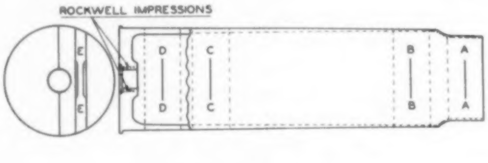


FIG. 2 TEST-SAMPLE LOCATION, CHARACTERISTIC STRUCTURE, AND PROPERTIES
(Illustrations reduced to one half of original size in width.)

SPECIFICATIONS

Specifications for cartridge cases are written by government agencies and differ slightly in detail. Typical of these specifications is the Army specification 50-46-1B. These specifications cover the details of the temper and physical properties of Army artillery cases. Details of dimensions are covered by reference to standard drawings which are included as a part of the specifications.

In Fig. 1 is shown a sketch of a typical cartridge case. The physical properties and temper of the various parts of the case will vary slightly depending on the gun and the explosive charge it must contain. Cases are also divided roughly into fixed and semifixed ammunition. Fixed ammunition contains a fixed quantity of explosives and the projectiles are tightly fitted into the mouth of the case. In semifixed ammunition the charge is varied and the projectile is not held in the mouth of the case. This difference controls the desired characteristics of the mouth of the case. The table attached to the sketch in Fig. 1 lists the tensile strength and hardness requirements for the 75-mm M18 fixed-ammunition case.



TYPICAL
SPECIFICATIONS FOR CARTRIDGE CASES
75 MM - M18

PHYSICAL PROPERTIES

POSITION	MIN TENSILE STRENGTH LBS / SQ IN
A	45000
B	45000
C	65000
D	65000
E	80000

PRIMER HOLE HARDNESS -
ROCKWELL - B 65 (1/16 BALL 100 KG LOAD)

FIG. 1 SKETCH OF TYPICAL CARTRIDGE CASE

From the physical properties specified it is apparent that the various portions of the case should be processed differently in order to meet the requirements. The types of microstructure necessary to produce these conditions are shown in Fig. 2 together with the tensile-strength and Rockwell-hardness values at these points. The point *A* represents a structure annealed to a fairly fine grain as a result of the mouth anneal. The point *B* shows a very fine-grained structure resulting from the taper-annealing operation. A slight amount of cold work may be left from the tapering operation, although this is not apparent from the structure. The points *C* and *D* are in the severely cold-worked condition resulting from the final drawing operation, and the point *E* in the base is also in the cold-worked condition as a result of the heading operation. The latter point is notably less severely cold-worked than the points *C* and *D*. These structures are in accordance with the specifications.

In addition to the requirements involving dimensions and physical properties there are those requirements which seek to

insure the satisfactory storage of the cases either loaded or unloaded for indefinite lengths of time. Corrosion is a hazard in storage of all metal components, and although brass is a relatively noncorrosive metal, there is danger of failure by season cracking. Season cracking is due to the combined action of stress and corrosion. The stress may be the result of the cold-working, that is, internal stress or, in the case of fixed ammunition, the result of the insertion of the rigid projectile into the mouth. The corrosion is usually the result of intercrystalline attack by ammonia in combination with moisture and oxygen.

The specifications are set up to prevent the possibility of the production of cases containing internal stresses. Internal stresses can be detected by immersion of the case in a mercurous-nitrate solution. By a simple displacement action copper and zinc are removed from the case surface and mercury deposited in their place. Liquid mercury acts very much like the ammonia, moisture, and oxygen combination in attacking the grain boundaries under stress. The Army specifications require a 30-min immersion in a 1 per cent solution of mercurous nitrate after the cases have been cleaned in a 40 per cent nitric-acid solution. Following the immersion in mercurous nitrate, the mercury is volatilized from the case surface and the sample carefully examined for cracks. Cases for fixed ammunition are required to be tested after plugs, the same size as the maximum projectile, have been inserted in the mouth of the case. This is done to make certain that the deformation caused by the insertion of the projectile will not cause stresses in the wall of the mouth sufficient to produce season cracking of the case.

STRUCTURE AND PROPERTIES

In order to withstand the bursting effect of the explosive charge, cases are made with a heavy base and with a side wall, which is heaviest at the base, tapering in thickness as well as diameter toward the mouth. The tapering of the wall thickness would normally result in lesser cold-working of the wall at the base. Actually, the opposite is required, and the tapering of the wall from the inside is carried through the entire series of draws. Therefore, the final draw is such as to produce a cylindrical shell with a heavy rounded bottom and a side wall tapering gradually in thickness toward the mouth. The heavy bottom has received but little cold-work in the last draw but the side wall is severely cold-worked in the heaviest portion near the base. In order for the bottom to have the necessary strength it must be cold-headed to its approximate final shape. After heading the case cannot be annealed in entirety and such other anneals as are necessary must be local anneals to prevent softening of the base and lower side wall.

While the case shell as drawn tapers in the side wall it is not possible to produce a diametrical taper by such an operation. It is therefore necessary to introduce a tapering operation to

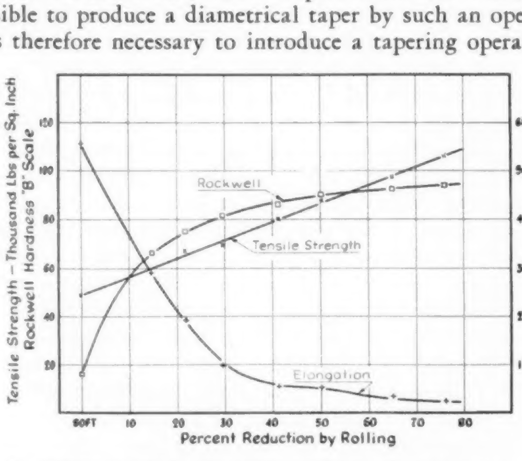


FIG. 3 ROLLING CHARACTERISTIC CURVES, SHEET CARTRIDGE BRASS ANNEALED AT 0.100 IN. GAGE—GRAIN SIZE 0.058 MM

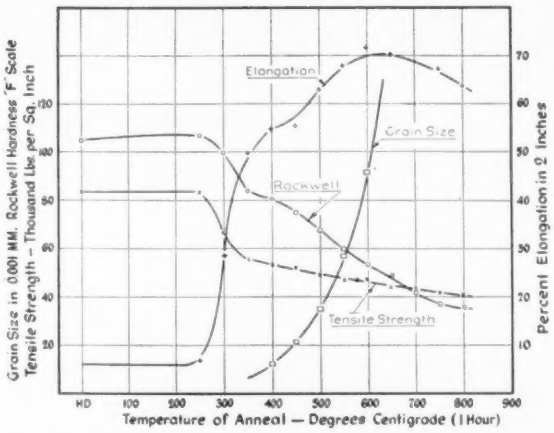


FIG. 4 ANNEALING CHARACTERISTIC CURVES, SHEET CARTRIDGE BRASS ROLLED 50 PER CENT HARD TO 0.050 IN. AND ANNEALED AT INDICATED TEMPERATURES

produce the general taper and the reduced mouth-diameter characteristic of most cases. In order to perform the tapering and reducing operation it is necessary in most types of cases to anneal the open end. This is done by immersing the open end and about half the length of the case in a molten salt bath. The case is then reduced to its final form and the mouth is again annealed if the case is to be used as fixed ammunition.

Some consideration of the effect of these various cold-working and annealing operations may be helpful. Figs. 3 and 4 are characteristic curves which illustrate the properties of cartridge brass as they are affected by these processes. The curves in Fig. 3 are produced from experimental data obtained by cold-rolling a strip of cartridge brass various amounts and selecting samples for test after each pass through the rolls. The samples selected are tested for tensile strength, hardness, and per cent elongation. These data are then plotted against the percentage of reduction in thickness by cold-rolling. These curves show clearly the increase in tensile strength and Rockwell hardness which results from cold-rolling. The sharp decrease in ductility shown by the drop in the elongation values between 0 and about 20 per cent reduction indicates the reason for the annealing which is carried out between the various drawing operations and before the tapering operation.

The effect of annealing is shown in Fig. 4. These curves are developed by selecting a sample of cold-worked material which has been uniformly processed up to this point. The specimen is then cut into several short lengths which are annealed individually by exposing to various temperatures for 1 hour. The samples are air-cooled and then tested for tensile strength, hardness, elongation, and grain size. The results of these tests plotted against the annealing temperature produce the data and curves shown in Fig. 4.

It is to be noted that temperatures below about 250 C do not produce any change in properties except perhaps a slight increase in hardness. At about 300 C the brass softens rapidly and recrystallization occurs. These changes are indicated by the rapid increase in elongation or ductility and the decrease in hardness and tensile strength. Further increases in annealing temperature produce a somewhat further decrease in hardness and tensile strength and a very considerable increase in elongation. With the particular cold-worked material used in these tests, recrystallization is about complete at 350 C and the metal structure consists of a fine equiaxed grain, solid-solution structure. As the temperature is increased the size of the grains increases rapidly, and this increase in grain size accounts for the increase in elongation.

The point at which recrystallization occurs, the initial re-

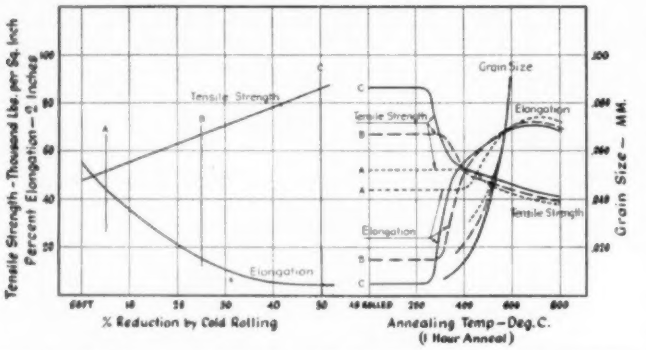


FIG. 5 SCHEMATIC DIAGRAM TO ILLUSTRATE EFFECT OF AMOUNT OF COLD WORK ON ANNEALING CHARACTERISTICS OF SHEET CARTRIDGE BRASS

crystallized grain size, and other details of the annealed properties are affected by the amount of cold work which the brass has received. An attempt has been made to illustrate this in the schematic curves shown in Fig. 5.

The curves to the left are illustrative of the characteristic effects of cold-working. To the right are shown together the annealing curves of samples *A*, *B*, and *C* which were annealed at various temperatures after 5, 25, and 50 per cent reductions by cold-working. It may be seen that as the amount of cold-working is reduced the temperature of recrystallization is increased and the initial grain size after recrystallization is also increased. It may also be seen that the less severely cold-worked brass is also slightly softer after recrystallization is complete. These characteristics are of interest in reference to the development of the structures shown in Fig. 2.

Considering first the structure of the base as shown in section *E*, a rather moderate amount of cold work is apparent. This section is taken from the tensile test piece cut from the base of a 75-mm case at a point about half way radially between the primer hole and the circumference of the base. This section shows a moderate amount of cold-working which is perhaps surprising in view of the amount of metal displaced in the heading operation. It must be remembered, however, that cold-working is due to the extent or distance through which a metal is moved rather than the volume of metal moved. There are portions of the heads of cartridge cases, however, which are more severely cold-worked than the section photographed, such as the primer-hole indentation and the section at the junction of the side wall and head.

The structures in sections *C* and *D* are those resulting from the last drawing operation. The amount of cold working is considerably greater than that shown by the structure *E*, and this is confirmed by the higher tensile strengths at these points. No evidence of recrystallization due to taper or mouth annealing is apparent in either section, although *C* is only an inch or two from the point of immersion for taper annealing. This is characteristic of the control necessary in these local annealing operations.

The structure in section *B* shows the effect of the taper annealing in a fine-grained recrystallized structure from the taper anneal. There is a small amount of cold work in this structure because of the small diametral taper at this point.

The structure in section *A* is particularly interesting. This is the only portion of the case which is completely without cold work. It is to be noted that the grain size at this point is slightly larger and more varied than at *B*. The amount of cold work resulting from the tapering operation is, in this particular case, very slight. As shown in Fig. 4 such cold-worked brass shows a less distinct change in physical properties on recrystallization than is normal. In order to be sure that the hardening from cold work is entirely removed it is necessary that the mouth anneal produce a visible change in grain size which carries with it a definite decrease in hardness and tensile strength.

Because the mouth of the case is the only portion that is entirely free from internal stress as produced, it is necessary that the entire case be relief-annealed. Experience with season cracking of cartridge cases in the last World War clearly demonstrated the danger from internal stresses. The advantages of relief-annealing were also demonstrated at this time. Such annealing is rather critical, however, in that the use of high temperatures is likely to result in softening of the cold-worked portion. The most efficient relief-annealing temperature is one just below the temperature at which softening begins. It is apparent from the data in Fig. 4, however, that this temperature will not be the same for all parts of the case and in order to be safe from softening a temperature is selected which will relief-anneal the most severely cold-worked portion without softening. The mercury-test results then indicate whether the temperature-time cycle selected has been sufficient to reduce the internal stress below the danger point. The results of tensile tests or hardness tests together with microexamination will indicate whether softening has taken place.

The success of the relief-annealing operation depends very greatly on the type of furnace used. At relief-annealing temperatures 250–275 C heat transfer by radiation is slow and there is great likelihood of overheating portions of the charge in an ordinary muffle furnace. Most recent practice has been to use convection heating methods which are ideally suited for anneals of this type. It assures rapid heating on the one hand and prevents overheating on the other. With such a furnace relief annealing can be controlled without softening the cases or having to reanneal several times to prevent mercury test failure. Salt-bath anneals are also very satisfactory for relief-annealing except for the difficulties in removing salt which might be left to solidify on the case. Care in washing will remove such frozen salt, however, so that anneals of this type are definitely practicable and may even save considerable time because of the more rapid heat transfer.

FINISH

In order to insure freedom from corrosion of the case or attack of the powder stored within the case in fixed ammunition, considerable care is given to clean the case from all acids or alkalies which might be active in this respect. It is somewhat unusual in a plant used to working finished brass articles to realize that cases are regularly produced with varying degrees of surface oxidation. There is no objection to such oxidation comparable to the objections which would be raised if attempts are made to remove the oxidation. In other words, the oxide is much the lesser of two evils and the acids or alkalies which would be necessary to remove the oxide are a much greater source of potential danger. The specifications specifically prohibit the use of sodium bichromate as a means of brightening the surface. Inferentially, such pickling solutions as sulphuric acid or nitric acid are also prohibited, as well as cyanide solutions.

The finished case must, therefore, be chemically clean from acids or bases, oil, grease, or dirt, although it may be tarnished with varying degrees of oxidation. This degree of surface cleanliness can only be attained by very careful rinsing operations. Mild caustics are necessary to remove the cutting lubricants used in machining the base and the rinsing is necessary to remove the caustic. The final rinse is normally of hot water so that rapid evaporation takes place and prevents water stain. It is desirable that the rinse waters be soft if possible so that no salt residue is left after evaporation in the final rinse.

The author wishes to thank the Bridgeport Brass Company for permission to publish these data.

THE WITTER SHELL-FORGING PROCESS

By JOHN H. LOUX

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THE fundamental elements of the Witter shell-forging process are a heating furnace, a press or upsetter for forming the billet into a pierced blank, and an Assel cross-roll mill.

Fig. 1 shows one No. 2 mill for shells up to 155 mm and three No. 1 mills which handle shells from 75 mm to 105 mm. The rated capacity of each of the furnaces for the No. 2 mill is 9600 lb of steel per hour. This is equivalent to eighty 155-mm billets for the Witter process. The combined capacity of the two furnaces would therefore be one hundred and sixty 155-mm billets per hour.

Cold billets are brought directly from the nicking and breaking, or other cutting unit, to a point where they may be picked up by the charger. As soon as the charger places a billet on the furnace hearth, he backs the machine out, moves to the discharge door, and brings out a hot billet. He then moves to the roller table, shown between the two furnaces, and deposits the billet on this table. About twenty seconds later the operator of the second furnace discharges a hot billet onto this same roller table. The two furnace operators continue to alternate in this manner until the run is finished. The hot billet travels down the roller table and drops automatically into the double-turret press. In this press the billet is formed into a short pierced blank after which it is automatically ejected and fed into the Assel cross-roll mill. After passing once through this mill it is carried into one pass of sizing rolls. The shell is then ready for the machine shop. The No. 1 units for making shells up to 105 mm operate in exactly the same way, except that the weight of the billet is much less.

The cold billets are brought by conveyers to the furnaces from the storage area and the hot billets are carried to the press on a common power-driven conveyer.

One primary advantage of the process is that only the Assel mill need be purchased if a manufacturer has a satisfactory heating furnace and a suitable press or upsetter available. Actually, the first installation was made with an old batch-type heating furnace, a reconditioned press, and Timken Roller Bearing Company's original Assel mill. That first installation is still capable of producing 75-mm shell forgings at rates up to 250 per hr. Where new furnaces, new presses, and new mills are in operation this production rate has actually been increased to more than 400 shells per hour on short runs.

The heating of the billets is especially important. In the conventional push-bench method, some degree of eccentricity can be corrected with the deep rough machine cut that follows the forging operation. In the Witter process this extra steel is not required and a smaller billet may be used.

The need for uniform heating of billets should be stressed. Mills are in operation with furnaces that are being pushed beyond their rated capacities and in every case rejections have increased proportionately.

The trend is definitely toward rotary-type heating furnaces rather than batch-type furnaces, because the rotary furnace has proved superior to the batch type in both speed and quality of heating.

The piercing press, which forms a shell blank from the hot billet, may be one of a variety of types. Single-punch and single-die presses, board and steam drop hammers, or conventional upsetters have been found suitable for this operation. To keep up with a production of 250 shells per hour a group of standard presses or a pair of upsetters is required for each Assel mill. Ordinarily, from 60 to 70 blanks per hour are produced from a conventional press and perhaps twice that many from a hammer or upsetter.

One of the high-production presses recommended especially for the Witter process is capable of supplying the entire requirement of the Assel finishing mill. This press is of the double-turret type, with six punches in one head revolving vertically, and with six stations in one head revolving horizontally. One station is for loading, the second for piercing, the third for ejecting the shell, the fourth for resetting the ejector, the fifth for water-cooling spray, and the sixth for oiling.

The unit shown in Fig. 2 is for 75- to 105-mm shells. It requires a 50-ton press for the piercing turret and a 60-ton press for the forming operation. The punches revolve continuously into a cooling tank set in the floor. A press of this same design is available for larger forgings up to 155 mm.

The pierced blank made from the hot billet is shown in Fig. 8. The small end of the blank enters the finishing mill and the blank is rolled to an outside diameter approximately equal to the diameter at this small end. The hole in the blank is large enough to permit easy entry of the mandrel used in the finishing mill. The mandrel is a smoothly machined tool having exactly the same contour and diameter as the cavity inside the finished shell. It is inserted in the blank before the blank enters the mill rolls.

The usual equipment for rolling seamless tubing includes a billet-heating furnace, a piercing mill, in some cases a reheat furnace, a plug-type rolling mill, a reeler, a reheat furnace, and a sinking mill with 14 or 16 passes. In the Assel mill process of rolling seamless tubing, a billet furnace, a piercing mill, the Assel elongator mill, and a three-roll sizing mill are all the units required.

The conventional tube mill has no mandrel, or plug, inside the tube during the entire rolling process. To roll a shell in this type of mill, exceedingly accurate plug guides would have to be provided and a plug, or mandrel, would have to remain in the shell as it passed through the mill, the reeler, the reheat furnace, and all fourteen stands of the sinking mill, to maintain the dimensions of the inner cavity.

When rolling shells in the Assel mill, Fig. 3, the shell revolves rapidly (about 600 rpm) as it feeds into the three cross rolls. A mandrel extends all the way into the cavity and maintains a constant inside diameter. This mandrel is not removed until after the shell leaves the sizing rolls.

Fig. 4 is a view looking toward the feed end of the three-roll Assel mill; *A* is the inclined receiving chute down which

Presented at the National Defense Meeting, St. Louis, Mo., Sept. 10–13, 1941, of The American Society of Mechanical Engineers. Slightly abridged.

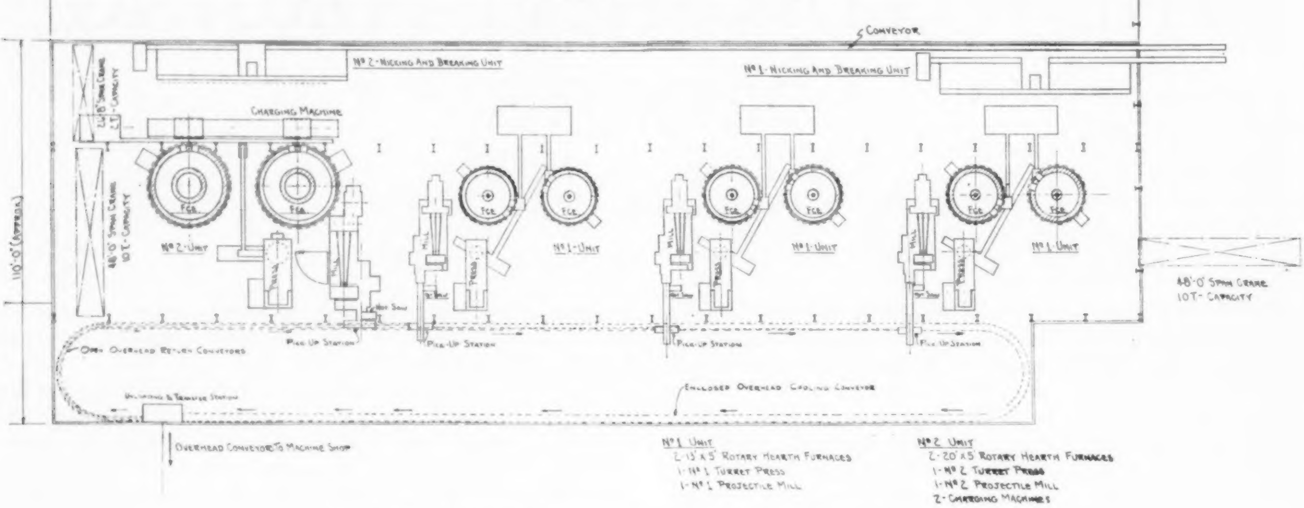

FIG. 1 LAYOUT OF SHELL-FORGING PLANT FOR WITTER PROCESS
(Three No. 1 units for 75-mm to 105-mm shells and one No. 2 unit for shells up to 155 mm.)

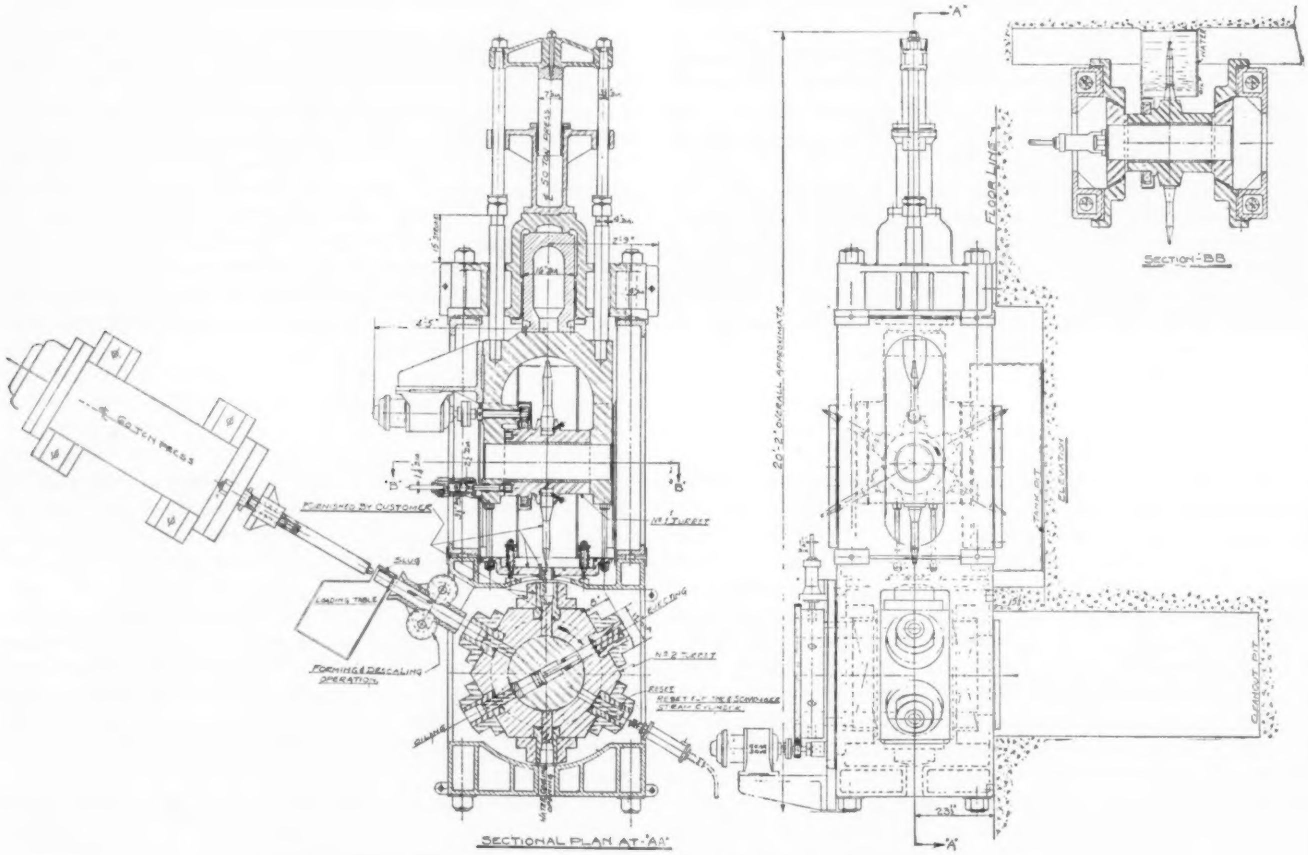

FIG. 2 DOUBLE-TURRET FORMING AND PIERCING PRESS FOR 75- TO 105-MM SHELL

pierced blanks are rolled from the turret press and A' indicates the guide cannon that is used for entering the billet into the three humped rolls. B is the stub mandrel shown in position for entering the cavity of the pierced blank. B' is the pressure cylinder which keeps the mandrels bottomed in the blank cavity during the rolling operation. If the pressure in this cylinder is allowed to drop too low, the mill rolls will actually squeeze the mandrel part way out of the shell.

The disk partially visible in the foreground is a heavy flywheel, in front of which is the gear drive which transmits power to the three hump rolls through the drive spindles.

Fig. 5 shows the discharge end of the mill. C indicates the receiving cradle for the shell after it has been rolled and the tilting cylinder which is used to deliver the shell, with mandrel still inserted, to the gravity conveyer. The gravity conveyer D delivers the shells directly into position for the final sizing operation.

The sizing head assembly E is suitable for using either rolls

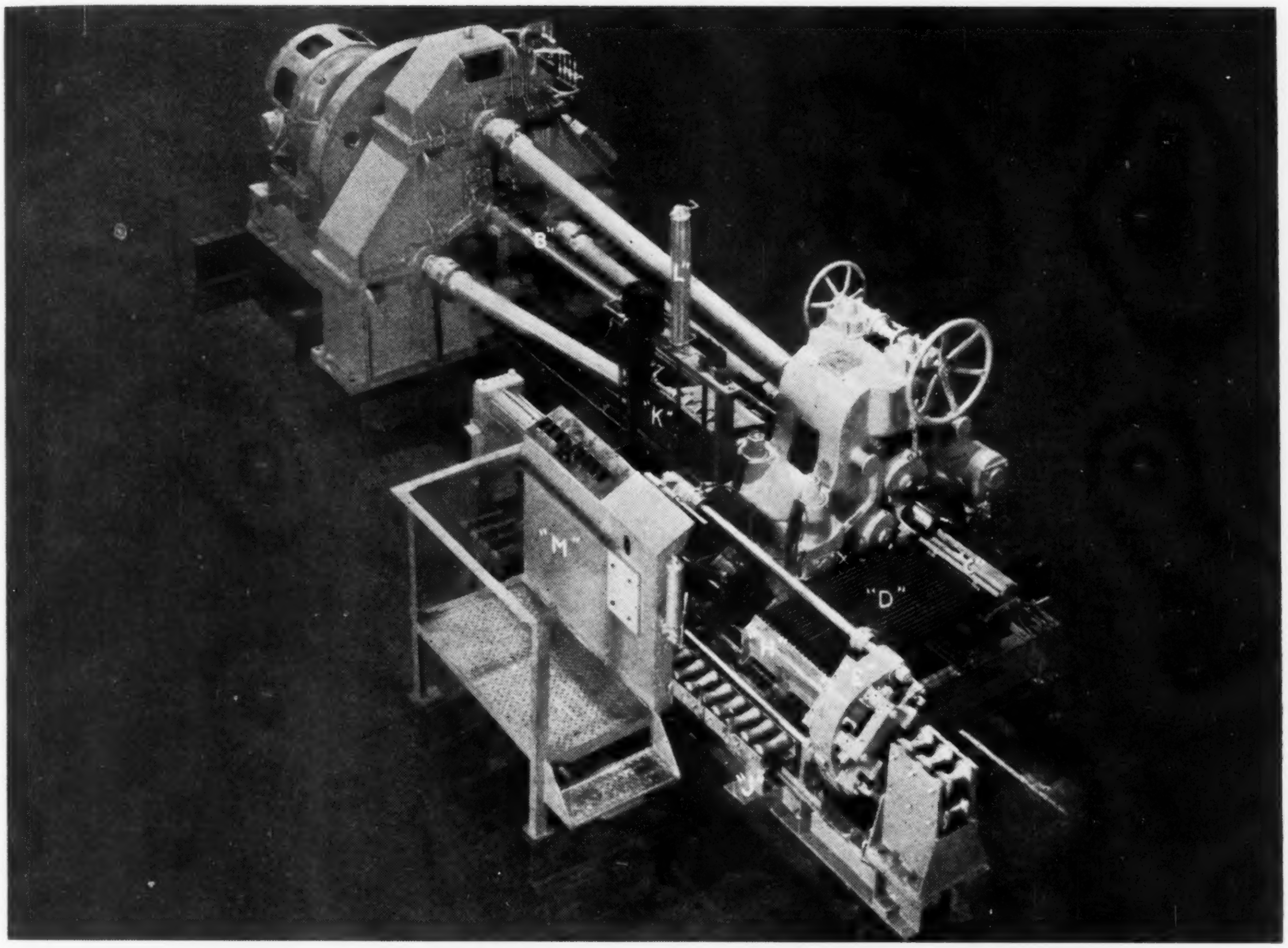

FIG. 3 ASSEL CROSS-ROLL ELONGATOR MILL

(B = Stub mandrel; C = cradle to receive shell after rolling; D = conveyer; E = sizing head assembly; H = cradle for stripped mandrel; J = conveyer to carry stripped mandrel to cooler; K and L = mechanism for feeding mandrel into pierced blank.)

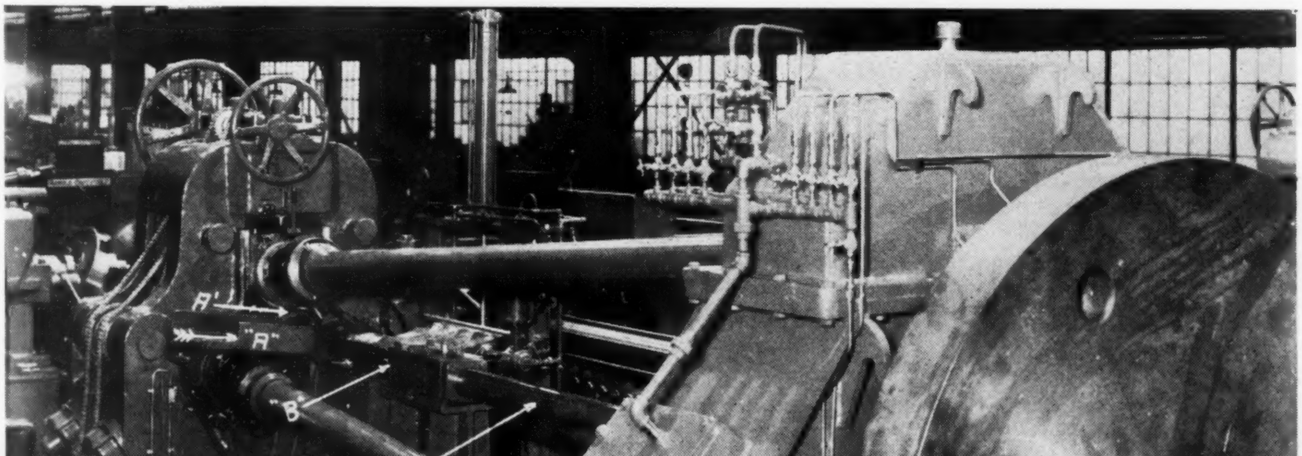

FIG. 4 FEED END OF CROSS ROLLS WHERE BILLET ENTERS

(A = Chute to receive billet; A' = guide for billet entering cross rolls; B = stub mandrel; B' = pressure cylinder.)

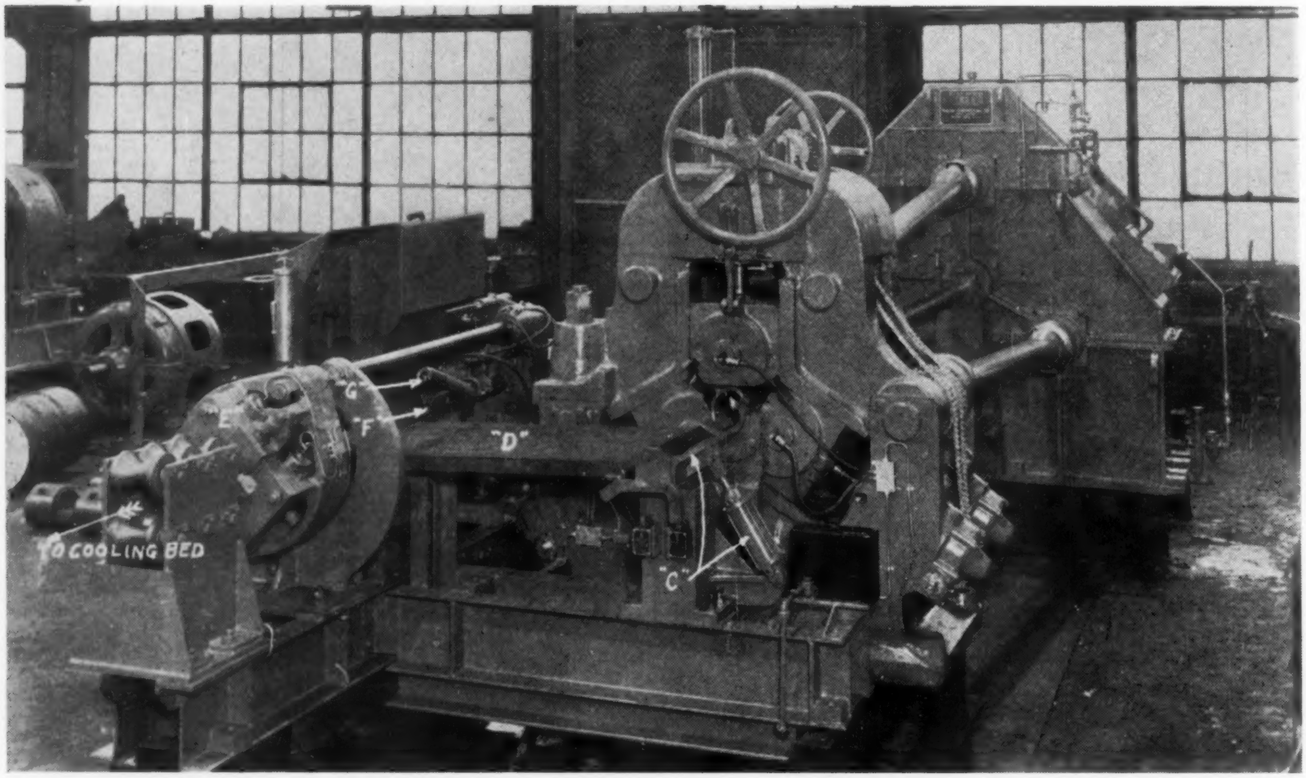

FIG. 5 DISCHARGE END OF CROSS ROLLS AND SIZING ASSEMBLY

(*C* = Cradle to receive shell after rolling and tilting cylinder; *D* = conveyer; *E* = sizing head assembly; *F* = sizing plunger head; *G* = clamp for stripping mandrel.)

FIG. 6 CONTROL SIDE OF ASSEL MILL

(*C* = Cradle to receive shell after rolling; *D* = conveyer, *E* = sizing head; *F* = sizing head plunger; *G* = clamp for stripping mandrel; *H* = cradle for stripped mandrel; *J* = conveyer to carry mandrel to cooler; *M* = operator's platform.)

or draw rings, as preferred. Both methods have been found satisfactory and both are still in use. *F* is the sizing plunger head. This head pushes on the mandrel and forces the shell into the sizing rolls. Before the shell leaves the sizing head, an automatic clamp *G* grasps the end of the mandrel and automatically strips it from the shell. Two small latches, only one of which is visible, prevent the shell from pulling back into the sizing rolls while the mandrel is being stripped.

After the mandrel is stripped from the shell, it lies in cradle *H*, Fig. 6, and is then automatically dumped onto the roller conveyer *J*, which carries it to the cooling equipment. Here it awaits its turn to be used again.

The platform *M* directly in front of the machine is the operator's platform with all controls located within easy reach.

Fig. 7 shows how little floor space is required for this shell-rolling mill. This particular unit is the No. 1 size for making shells from 75 mm to 105 mm. The No. 2 mill for shells up to 155 mm requires approximately one third more floor space and includes essentially the same parts as the smaller mill.

Summarizing briefly, the operation of the mill proper is:

1 The motor, located at one end of the mill, drives a central gear through a heavy flywheel, which takes up the shock of shell rolling. The central gear drives the three mill rolls.

2 The blank enters the receiving chute from the turret press, a mandrel is inserted in the cavity, and the blank and mandrel are pushed into the mill rolls. In these rolls the blank is elongated into a shell and the shell, with the mandrel inserted, is discharged into the receiving cradle. From here it rolls down into position in front of the sizing rolls.

3 Just as the shell leaves the sizing rolls, the mandrel is stripped from it. This mandrel then drops onto a roller conveyer and is kicked from this conveyer into a cooling tank, where it remains until it is returned automatically to the front of the mandrel pressure cylinder.

4 The shell, after leaving the sizing rolls, is taken directly to the next operation.

Fig. 9 shows a section of a pierced blank, shown in Fig. 8, forged in the double-turret press. The mandrel fits loosely in this cavity until the pressure of the rolls causes the blank to elongate, thus wrapping the metal tightly on the mandrel.

To find out how the metal flows when elongating, an experiment was run with a stainless-steel pin set in the walls of a pierced blank. The blank was then rolled through the Assel mill. In the finished section the two ends of the pin were still opposite, but the center had been pushed out in the direction of elongation. This proved that the metal was actually being

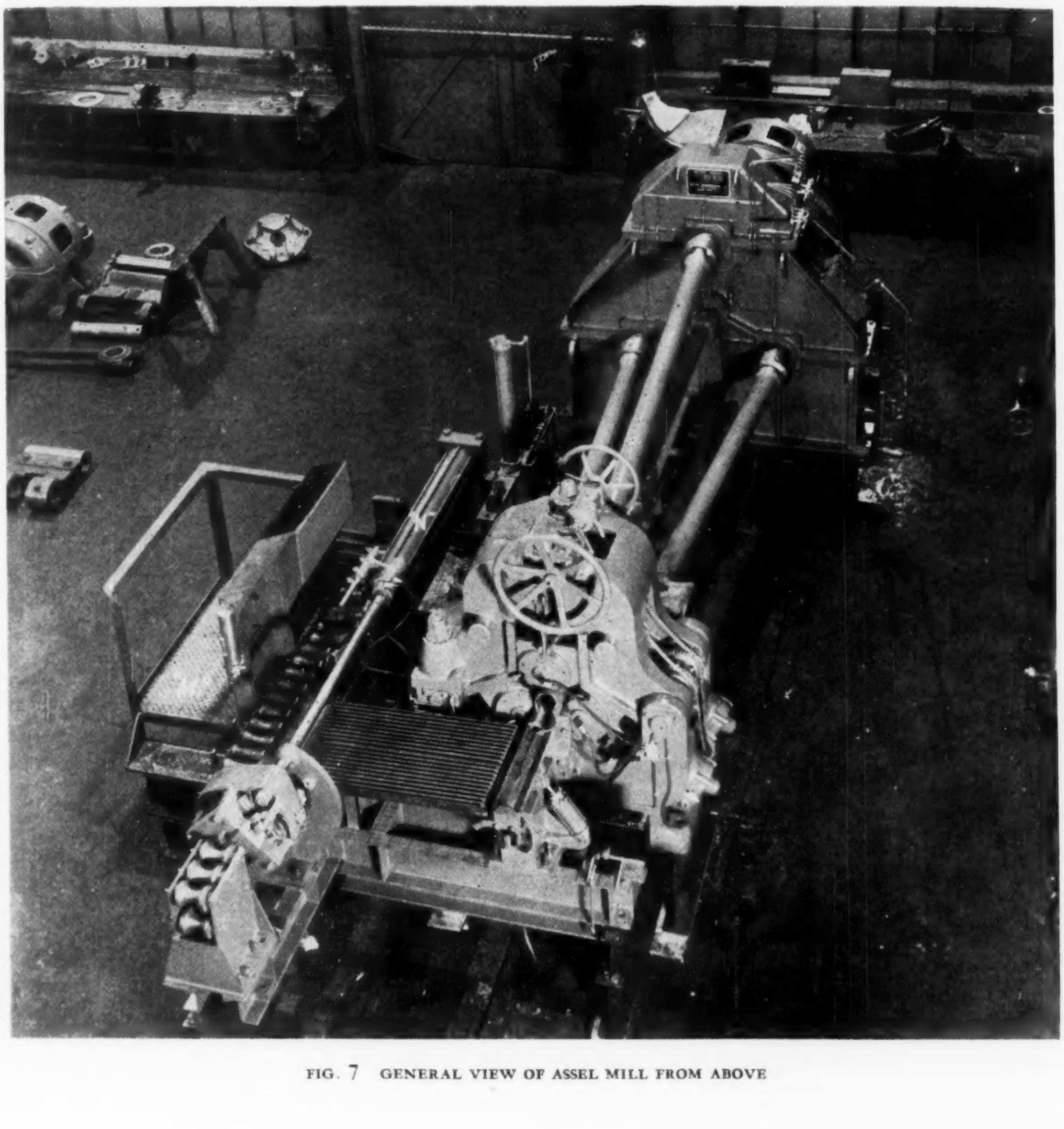

FIG. 7 GENERAL VIEW OF ASSEL MILL FROM ABOVE

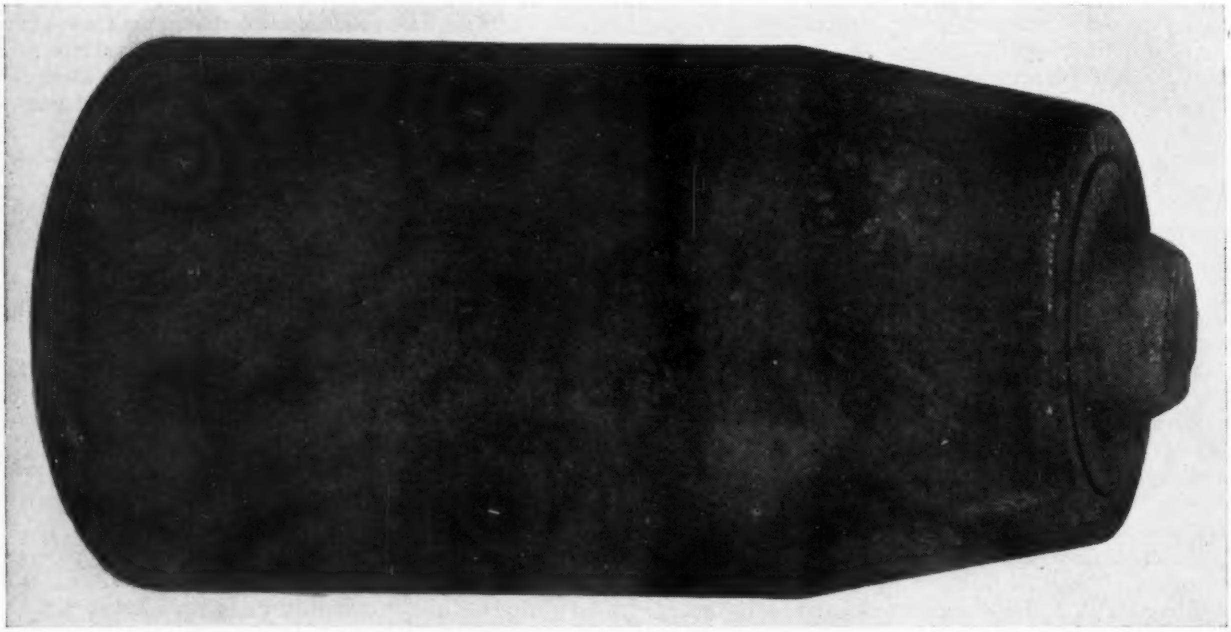

FIG. 8 PIERCED BLANK MADE IN DOUBLE-TURRET PRESS

FIG. 9 CROSS SECTION OF PIERCED BILLET

squeezed out between the mandrel and the rolls, and that the two surfaces moved forward at approximately equal rates.

Fig. 9 also shows clearly the uniform grain structure and the metal flow at the closed end.

Fig. 10 is a cross section of a 75-mm shell forging after it has passed through the finishing mill. The uniformity of wall thickness and the structural grain refinement are apparent. In considering the concentricity of this shell, it must be remembered that the shell has passed through a three-roll, cross-rolling mill, and not through grooved rolls. The shell actually spins as it passes through these rolls and this gives the mill an excellent chance to correct whatever eccentricity that may have occurred in the piercing operation. Fig. 11 shows a 75-mm high-explosive-shell forging on which a test was run to determine how much eccentricity the mill could correct with very little wall reduction. The shell forging was selected deliberately with the cavity considerably off-center and the finish of the cavity was rough and unsatisfactory. The shell was heated and then rolled through the finishing mill and the result is shown at bottom of Fig. 11. The total reduction in outside diameter was $^1/_8$ in. and the center of the cavity was brought very nearly in line with the center of the shell. Furthermore, there was a decided improvement in finish of the bore and a structural refinement in the steel itself.

It would be foolish to say that any eccentric shell forging can be corrected by passing it through the Assel mill. However, experience has proved that from 50 to 80 per cent of the eccentricity can be corrected when reducing a pierced blank to a shell. This feature is of great importance to anyone planning to pierce with an old press or upsetter that is out-of-date and not too

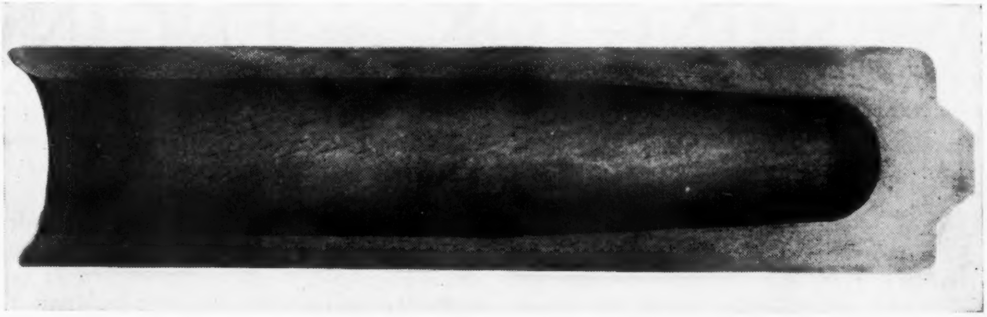

FIG. 10 CROSS SECTION OF 75-MM SHELL FORGING AFTER PASSING THROUGH FINISHING MILL

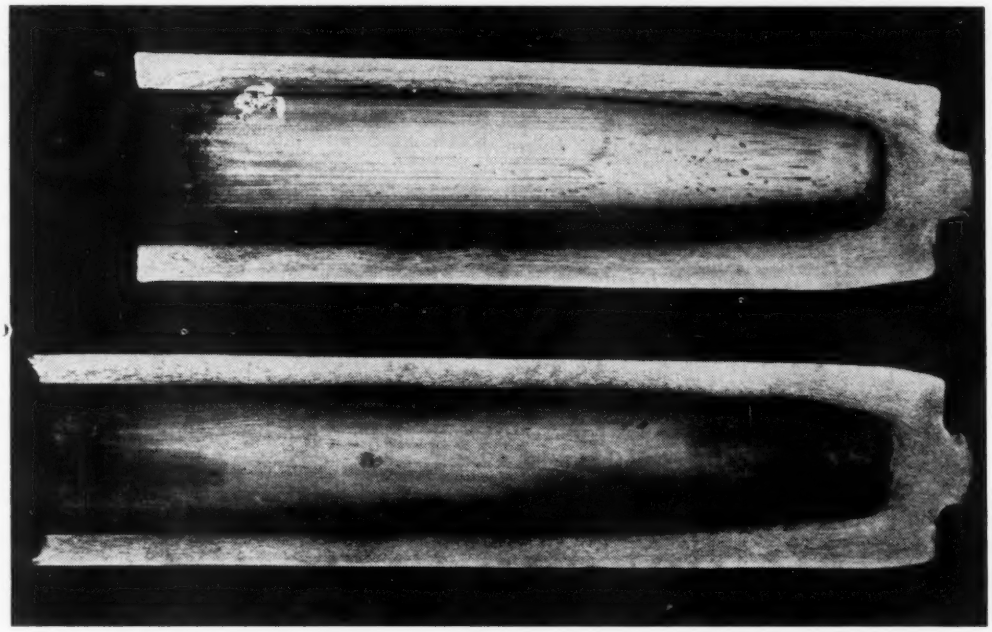

FIG. 11 75-MM SHELL BEFORE AND AFTER CORRECTION FOR ECCENTRICITY IN FINISHING MILL
(*Top:* Longitudinal etched section of upset 75-mm high-explosive shell. *Bottom:* Longitudinal etched section of same shell after rerolling. Note improvement in finish of bore and structural improvement from only 1/8 in. reduction in diameter.)

accurate. For example: The upset forged shell just mentioned was reduced 1/8 in. in diameter when it passed through the Assel mill. This was done not only to correct the eccentricity of the upset forging but also because a reduction of 1/8 in. would give the diameter ordinarily required after rough-cutting. Moreover, the Witter process can roll all shells to a diameter so close to the rough-cut dimension that the rough-cutting operation may be entirely eliminated.

The fact that by means of this process shells can be rolled to close tolerances means more than just a saving in machining cost. It means also a saving in steel and permits the use of a much smaller billet. Ordinarily, a 75-mm billet weighs about twenty pounds. For the Witter process this weight need be only 16 lb. The respective weights for other sizes of shell are as follows: For the 105-mm shell, 44 lb as against 36 lb; and for the 155-mm shell, 145 lb as against 120 lb. The average saving in steel amounts to 20 per cent of the billet weight. Not all users of the Witter process take advantage of this smaller billet, however, because they are required to ship forgings of the same size as those shipped by other manufacturers.

In addition to the saving in steel, the saving in new equipment, and a saving in man power, high production rates are obtained. From the latest operating data, a comparison of production rates with older processes as against those obtained with the Witter process would be: For 75 mm, 100 per hr as against 360 per hr; for 90 mm, 80 against 300 per hr; for 105 mm, 65 against 240 per hr; for 155 mm, 50 against 160 per hr.

Although these high production rates have never been maintained continuously twenty-four hours a day, on short runs they have actually been exceeded. As a matter of fact, this mill has never been run at its top capacity. The only way possible to run this shell rolling mill at its full rated capacity is to install presses and furnaces that will feed it. Anyone considering the use of the mill with already existent press, upsetter, or furnace equipment, *must* figure on a sufficient number of these existing units.

Through the Witter process, with new and modern furnace equipment, and with the high-production double-turret press, the cost of 75-mm shell forgings is $39.50 per thousand. This figure covers labor and maintenance, but overhead and amortization costs must be added. It is based on a production rate of 250 shells per hr. If slower presses and furnaces are used, this cost may be increased.

The cost of upkeep and replacement of dies and rolls, which is included in figure cited, is actually quite small. Before it becomes necessary to redress the rolls in the mill proper, approximately 200,000 forgings may be run through. Then, only 1/6 in. of stock need be removed from the roll diameter. This redressing operation can be done six or seven times before the roll must be discarded.

Was WASHINGTON *an* ENGINEER?

By GEORGE F. BUSH

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YES, he was. There is plenty of evidence to prove this contention; not the thin doubtful variety, but direct incontroversial facts culled from the accounts of his vast and eventful career. As Commander in chief of our armed forces, conducting this country's first vital military campaign, and as the first President of the United States, he exhibited many times those qualities and habits of mind which are so characteristic of the engineer. He had that ability to recognize the fundamental problem, to organize all pertinent data to determine the existence of a solution, and then to employ various physical skills in the execution of the solution. What makes this ability seem all the more remarkable is the fact that he was essentially self-trained and self-schooled.

He studied the elementary subjects of the times under the direction of tutors, for, unlike Europeans, he did not have access to technical schools, because there were none in this country at that time. Washington's feeling regarding the necessity for such a school in this country cannot be better expressed than by citing a provision in his will[1] for the establishment of a university "to which the youth of fortune and talents might be sent for the completion of their Education . . . in the arts and sciences. . . ." It is a happy coincidence that this partial provision was in the form of fifty shares of stock in the Potomac (Canal) Company, an engineering venture proposed, promoted, and carried through by Washington himself, and that the beneficiary of this provision is today a great university bearing Washington's name in a city also bearing his name and consisting in part of an engineering and scientific school which is almost as old as the university itself.

When only seventeen, young Washington was appointed by the College of William and Mary as a (Culpeper) county surveyor. Years later, a lawyer working with land titles in Virginia declared that the only land surveys on which he could depend were those of Washington. Thus, at the age of seventeen, Washington began a full career of public service in an engineering capacity.

AS A MILITARY ENGINEER

While Washington was engaged in the French and Indian War on the side of the British, he supervised much engineering work of a military nature, work such as the building of roads, forts, and small bridges and the making of maps. His sketches of Forts Loudon, Cumberland, and Necessity are contained in the Washington papers[2] in the Library of Congress. Unquestionably, the experience there gained was of untold value in the later military campaigns he conducted in the Revolutionary War. His engineering capacity for organization, the careful checking of all items of the problem, and his thoroughness of preparation trained him for those turbulent days during the occupation of Dorchester Heights, which occupation finally forced the British to abandon Boston; for those daring hours during the surprise Christmas Eve attack on the carousing British in Philadelphia after the crossing of the Delaware near Trenton (not a mean engineering feat); and for those tense moments during the silent march of his army from New York to Yorktown, culminating in the final battle of the war. In these troubled times it is worthy of note that in 1756, Washington wrote:[3] "As defensive measures are evidently insufficient for the security and safety of the country, I hope no arguments are requisite to convince of the necessity of altering them to a vigorous offensive war, in order to remove the cause."

It may not be too much to say that, as a result of his engineering-military knowledge, our country is free and independent today.

COMMERCIAL VENTURES IN ENGINEERING

Thinking in terms of engineering, Washington, with five partners, founded the Great Dismal Swamp Company as the beginning of a reclamation project. The swamp is in Nansemond County, Va., and 40,000 acres of land were purchased from Marmaduke Norflet. The scheme was to drain the swamp, which, strangely enough, is higher than the surrounding country. Unfortunately, the venture was never profitable. It seems that Washington was fated to struggle more successfully with the land than with the water.

In the Potomac Canal project, which he really inaugurated in 1754, with a trip down the Potomac "to discover the Navigation of the Potomack,"[4] Washington assumed a very active role, spending a major portion of his then very busy life supervising, among other constructions, those of the large number of locks necessary in the rugged and hilly country at the Potomac end of the canal. Jefferson's letter to Washington, dated March 15, 1784, reads in part:

"The union of this navigation (Ohio) with that of the Potowmac must be accomplished now if we ever mean to have it. All the world is becoming commercial. . . . For the trade of the Ohio or that which shall come into it from its own waters of the Mississippi, is nearer to Alexandria than to New York by 750 miles. . . . Nature then has declared in favor of the Potowmac, and through that channel offers to pour into our lap the whole commerce of the Western world."

Actual work was begun in 1786, on the locks at Great Falls, Virginia, just 16 miles from Washington, with James Rumsey in charge, the same James Rumsey who two years before caused Washington to note in his diary[5] that he had seen at Bath "the model of a boat constructed by the engenious Mr. Rumsey for ascending rapid currents by mechanism." Another note[6] concerning power-propelled boats shows Washington ever-mindful of the economic importance of developing an adequate inland-waterway system. It reads, "In the Evening (November 4, 1785) a Mr. Jno. Fitch came in to propose a draft and model of a Machine for promoting Navigation, by means of a steamboat." Incidentally, it was this same John Fitch who operated a steamboat of his own invention on the Delaware, as a part of a regular transportation service, 19 years before Fulton operated his on the Hudson.[7]

The story of Washington as a city planner and city builder is an extensive one. Innumerable incidents could be cited to show the essentially engineering mind which Washington pos-

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[1] Fairfax County Courthouse, Fairfax, Va.

[2] Manuscript Section, Library of Congress, Washington, D. C.

[3] "Writings of Washington," vol 1, Bicentennial Edition.

[4] "Writings of Washington," vol. 2, part 1, Bicentennial Edition.

[5] "Honor to George Washington and Reading About George Washington;" pamphlet No. 13, entitled "Washington as Engineer and City Builder;" published under the Direction of the U. S. George Washington Bicentennial Commission, Washington, D. C., 1932.

[6] "Writings of Washington," vol. 9, Bicentennial Edition.

[7] "The John Fitch Papers," Library of Congress, Washington, D. C.

sessed. He knew that if a thing were to be well done, it was necessary to find the best man for the job; but that, if a thing were to be done exactly right, it would be necessary to do it oneself. That is why he devoted as much of his personal attention to the planning and building of the city of Washington as the pressure of his presidential duties would allow. He selected L'Enfant, a French engineer who served in the Revolution, to prepare a plan of the city, and it was the crystallization of L'Enfant's plan which Washington personally achieved after L'Enfant's dismissal. That the nation's capital today is one of the most beautiful cities in the world is due in no small measure to Washington's initial sponsorship, and to the engineering methods he employed.

WASHINGTON'S AGRICULTURAL EXPERIENCE

There can be no doubt that Washington, in the planning and building of the city of Washington, drew profitably from the bountiful experience he had gained as the owner and master of the Mt. Vernon estate. There he completely renovated the old mansion house after his own designs and drawings. He supervised all the trades essential to serving the wants of an independent community, trades such as milling, distilling, tanning, blacksmithing, wagonmaking, spinning and weaving, and brickmaking. He was interested in the improvement of his land and he conducted his farming on a very scientific scale. Detailed descriptions of plant breeding, soil analysis, and experiments to increase crop yield can be found in Washington's later papers.[8] His horticultural specimens were the marvel of the many dignitaries who visited him at Mt. Vernon. For use at Mt. Vernon, our first President invented a horse-drawn barrel plow[4] which furrowed ground and planted seed in one operation.

[8] "The Agricultural Papers of George Washington," edited by Edwin Brooke.

ORIGIN OF THE AMERICAN PATENT SYSTEM

Protecting for the originator all newborn technical ideas is the American patent system. On January 8, 1790, in his first anniversary address, Washington said:

"I cannot forbear intimating to you the expediency of giving as effectual aid to the introduction of new and useful inventions from abroad as to the exertion of skill and genius in producing them at home."

Later in the same year, just 152 years ago, the American patent system was established, when Washington affixed his signature to the First Federal Patent Act, legislation which he himself had urged the First Congress to pass. During the first three years in which the act was in effect, the granting of a patent involved virtually a meeting of the Cabinet, because the Patent Board consisted of Thomas Jefferson, Secretary of State, Henry Knox, Secretary of War, and Edmund Randolph, Attorney General. Washington, the President, signed the patent. To get a patent cost the inventor about $4. An old record kept by the clerk showed that John Fitch paid $4.39 for his steamboat patent.[9]

By virtue of these few facts from the technical phase of Washington's life, one not only appreciates that Washington *was* an engineer, but one understands the extreme importance of this engineering factor in the life of a man entrusted with the early destinies of our country. He knew the uses and strengths of materials and the weaknesses of men. In truth, he was prepared for Valley Forge years in advance.

[9] *New York Times*, Feb. 10, 1940.

Manufacture and Processing of Aluminum and Its Alloys

(*Continued from page 108*)

and certain thicknesses of plate are flattened by roller leveling and stretching. Round rod is generally straightened by roll straighteners, while bars of noncircular cross sections and extruded shapes are straightened by stretching only. Similar straightening and flattening operations are also conducted on common alloy products to improve the flatness or straightness, or both, of the material as produced by the various forming operations.

PURECLAD

Although all aluminum alloys exhibit relatively good resistance to corrosion, some of the heat-treated and aged strong alloys are considerably less resistant to corrosion than aluminum of high purity. To combine the great strength of strong alloys with the excellent corrosion resistance of the pure metal, a product called "pureclad" has been developed. Pureclad consists of a strong-alloy core between two films of high-purity aluminum. The thickness of the high-purity surface films is so chosen as to retain the maximum physical properties consistent with adequate protection of the alloy core against corrosion. Standard pureclad sheet products are fabricated with each film thickness amounting to approximately 5 per cent of the total thickness of the sheet. As a result, the tensile and yield strengths are approximately 10 per cent lower than corresponding values for the uncoated alloys.

The high-purity films are applied during the hot-roll operations. A slab of core metal consisting of one of the strong alloys, for example, 24*S*, is encased between two plates of high-purity aluminum containing a minimum of 99.7 per cent aluminum. The assembled slabs are heated to hot-rolling temperatures of approximately 800 F, depending on the particular core alloy, for the rolling operation. On the first pass through the roll the high-purity plates are welded onto the strong alloy core so as to make the coatings integral parts of the complete slab. From this point on the material is finished by subsequent hot-rolling and cold-rolling, exactly the same as ordinary sheet or plate would be. After the plates are once welded securely to the core metal, the relative thicknesses of the high-purity plates remain substantially constant, regardless of the amount of reduction made on the material.

It is a fortunate coincidence that the coating not only protects the alloy which it covers, but it also prevents attack on the sheared edges or the sections of the base alloy which may be exposed by scraps and abrasions. Such electrolytic protection arises through the more anodic character of the film as compared to the core.

MECHANICAL PROPERTIES

In conclusion, nominal chemical compositions and typical mechanical properties of some of the more widely used common and strong alloys are given in Tables 1 and 2 to show the wide range of mechanical properties covered by aluminum alloys.

SOCIAL SECURITY AND THE ECONOMY[1]

By FRANCIS S. DOODY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE work under review this month represents something of a departure from the kind of book which has been customarily reviewed in this series. Prof. Seymour Harris' "Economics of Social Security"[2] will never top a best-seller list; it is a technical book, and as such it provides rather difficult going. Yet, we feel no hesitation in suggesting it as this reviewer believes that the hourly returns to the reader from such a work will in the long run prove to be greater than those from material of a more popular nature. Books of the latter type, especially when their content is economic, come and go rapidly and the world is left little the wiser for their passing. Books of a technical nature, i.e., those which make some serious effort at impartial analysis of a particular problem, do, when they have been studied and mastered, make a lasting contribution to the reader's understanding.

Workers in a particular scientific field, we all recognize, owe it to themselves to become familiar with the scientific work that is going on in other fields. This is true, if for no other reason than the tendency of the public to accept the word of a "scientist" as law, even though he may be making a pronouncement in a field in which he has no more training than anyone else. Our observation applies with particular force to subject matter which comes under the jurisdiction of the social sciences. How often have we seen petitions, relating almost exclusively to economic or political matters, signed with an air of authority by natural scientists or Spanish professors! The title of "professor," e.g., is not an unrestricted franchise; it confers authority only in the field in which special training is possessed.

KEYNES MODEL FOLLOWED

From this point of view a work in economics which may be examined with profit is Professor Harris' latest publication. The "Economics of Social Security" has several merits. Analytically, the book is on a high level, the analyses are carried out in a truly scientific manner. The quality of the writing is less worthy of praise, yet it is probably typical of much scientific writing in economics. Occasional passages in the book remained quite incomprehensible to the reviewer, even after continued rereading, while in general the book seems to have been written backward. Parts II and III might well be read first and part I last. The outstanding merit of the book is its examination of the effects of the Social Security Act in all its ramifications. One cannot help coming away from the book impressed with the magnitude of the impact of the social-security program upon the entire economy.

Before proceeding with a presentation of the major results of the study, we would do well to present the main outlines of the analytical framework in which the material is presented. It is in its method of analysis that economics lays its claim to being a science. Analysis proceeds by the selection of assumptions and the construction of a model of economic reality, along simplified lines. The workings of this model are then examined and its conclusions are applied to reality, in so far as the particular assumptions permit. This is somewhat comparable to the laboratory technique, which examines the effects of a number of variables while holding others constant.

The model which Professor Harris employs is that of J. M. Keynes, the English economist. This particular model has enjoyed a considerable vogue in the last few years and may be roughly summarized as follows. Attention is focused on the national income of a particular economy and this national income is viewed as the resultant of (1) expenditures by consumers upon goods and services or, in other words, expenditures upon consumption, and (2) expenditures by producers upon plant, equipment, and the acquisition of inventories, or expenditures upon investment. Thus variations in the level of the national income are accounted for by variations in the level of these two classifications of expenditure, consumption and investment. Expenditures upon investment have, historically, been the dynamic factor producing changes in the national income, while expenditures upon consumption tend to vary as a result of changes in the national income in the preceding period of time. Causes of changes in the volume of investment lie in the changing relationships between the two determinants of the volume of investment, the costs of investment and the returns from investment. Thus when profit prospects are attractive and show promise of exceeding the rate of interest, large volumes of investment will be made. It is against the background of this theoretical model, it will be remembered, that Professor Harris carries out his analysis of the effects of social security.

In the Keynesian model an attempt to increase the volume of savings in the economy, either because of a decline in investment outlets or a reduction in the volume of consumption, will tend to drive down the level of the national income. Do the pay-roll taxes levied for social security tend to lower the volume of consumption and increase the volume of savings? Professor Harris, in company with many other economists, believes that the taxes do have this deflationary effect. However, the author believes that such taxes should be continued because they are in line with insurance principles (they make some association between benefits and contributions) while their deflationary effects may be offset by other government policies. Furthermore, the pay-roll taxes, particularly if they are shifted to consumers and profit recipients, may impinge upon the volume of savings, while the disbursements of benefits will in the future contribute toward a net rise of consumption.

The analysis summarized in the foregoing, he recognizes, holds true in periods of less than full employment of our economic resources and man power. But in times of full employment, consumption taxes serve to reduce the volume of consumption in a desirable way and permit the growth of investment expenditures, or, as today, inhibit inflationary tendencies resulting from excessive consumer purchasing power.

FINANCING OF OLD-AGE BENEFITS

Another important issue which is discussed is the question of financing old-age benefits by the accumulation of reserves or by a pay-as-you-go policy. Despite recent legislative trends in the direction of the latter policy, Professor Harris does not favor it. The pay-as-you-go policy would require severe taxes in the future when obligations are much larger. Not only does the reserve plan make provision now for meeting later

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

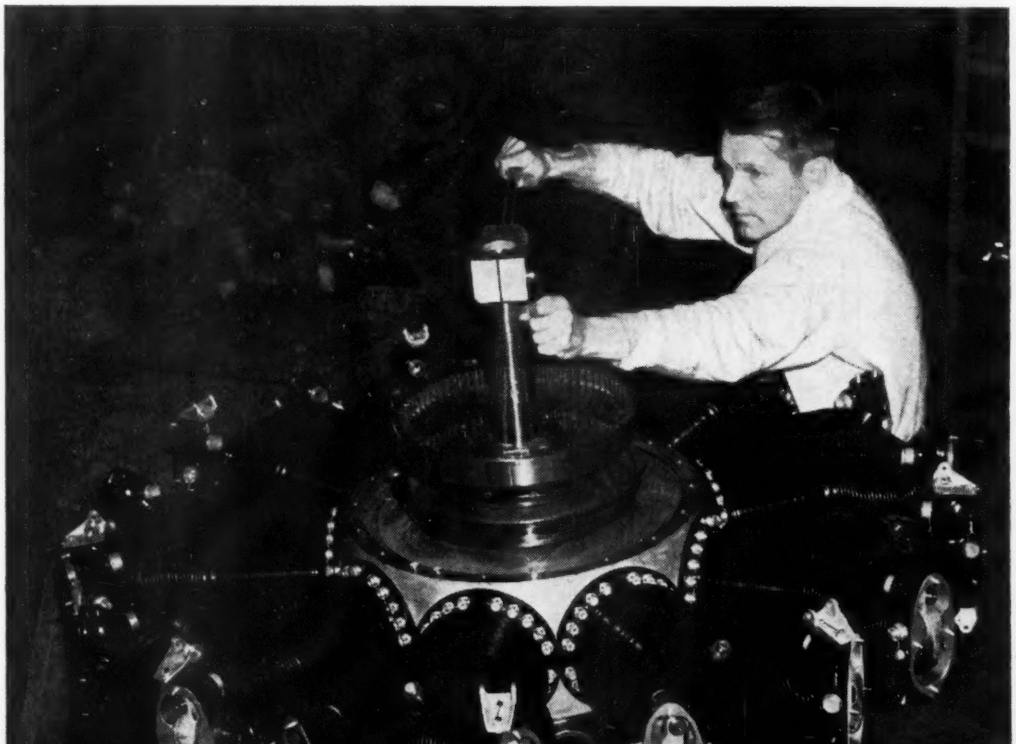
[2] "Economics of Social Security," by Seymour Harris, McGraw-Hill Book Co., Inc., New York, N. Y., 1941.

obligations, but it will prove cheaper in the long run in that earnings from reserves supplement tax receipts. Earnings on reserves have been held by some to be fictitious, but in answer to this Professor Harris points out that the outstanding private debt is reduced when reserve funds are placed in government bonds. Thus the fund receives income which otherwise would have gone to private bondholders. In this connection it is well to note that the social-security program, by providing a new market for government securities, has contributed toward the lowering of interest rates and, as reserves grow, is likely to be a more important factor in the future. In so far as this effect is transmitted to interest rates in general this is a favorable outcome in that it contributes toward an increase in the volume of investment.

Professor Harris looks with some apprehension upon the recent action of Congress in increasing the benefits to be paid in the early years and postponing the scheduled stepup in pay-roll taxes for 1940. This has meant the virtual abandonment of the reserve principle and is a result of a tendency to disregard problems of future financing. He even goes so far as to state that the attitude of Congress toward the tax program may foreshadow a future reduction of promised benefits or even a failure to fulfill promises made. The reserve program of course, was abandoned under the pressure of the depressed conditions prevailing in the thirties. The demands of the war economy may prompt a return to larger pay-roll taxes and reserves, which would prove very helpful in inducing economies of consumption.

The author next proceeds to apply many of the modern developments in economic theory to the problem of the burden of the tax on the employee. The generally accepted view that labor ultimately pays the cost either through a reduction of money wages or of employment is subject, Professor Harris points out, to important reservations. For example, social-security costs may be absorbed if an expansion of the money supply occurs. In this case the firm responds to the tax by maintaining employment and paying out increased amounts of money. This results in an expansion of demand for the fixing output and the tax does not prove harmful to the volume of employment. This result, the author notes, is but one of the several that are possible.

A study of the effects of social-security legislation, but a few of which have been indicated here, is likely to prove extremely fruitful in the years to come. This is true not only because of the magnitude and importance of the program itself, but because, in formulating the program, the Congress has unwittingly forged a new and powerful instrument for the control of the economy. This is evidenced, for example, in the current discussion concerning the raising of social-security taxes in order to counteract the inflationary tendencies of the moment. This procedure has much merit, but it is devoutly to be hoped that the potentialities of the social-security program for the control of the economy are not utilized in such a fashion as to lose sight of the long-time objectives and requirements of social security.



Hoit-Cushing, N. Y.

AIRPLANE ENGINES FOR VICTORY—WORKING ON A CYCLONE MOTOR

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Conservation and Salvage

BUREAU OF INDUSTRIAL CONSERVATION

A COMPREHENSIVE plan of industrial conservation, designed to secure the active co-operation of industry in the economic use of raw materials, and the salvaging of scrap needed for America's war industries is now operating in Erie, Pa., according to an announcement of the Bureau of Industrial Conservation, Office of Production Management.

The program was worked out by leading manufacturing interests of Erie, with the full endorsement of the Bureau of Industrial Conservation of the Office of Production Management. According to officials of the Bureau, extensive savings in the use of raw materials have already been effected, although the plan has been in operation less than three weeks.

The Industrial Salvage Section of the Bureau, drawing upon the experience gained in Erie, will sponsor the inauguration of similar programs in thirty-odd centers in the course of the next few months.

The Erie program was formally launched on December 12, when leading executives of the city's large and small industries and trade and business associations attended an organization meeting and set up an executive committee. This committee is composed of the following: F. E. Bliven, General Electric Co., chairman; R. C. MacElroy, secretary, U. S. Metals Products Co.; M. F. McCarty, Erie Forge and Steel Co.; Harry Bole, president, Erie Foremen's Association; and Dana Jones, secretary of the Manufacturers Association of Erie.

The executive committee then selected a subexecutive committee, composed of executives engaged in the manufacture of products generating such salvageable materials as iron and steel scrap, nonferrous scrap (brass, copper, aluminum, lead and zinc), waste paper, scrap rubber, cotton and woolen rags, and miscellaneous products.

The executive committee and the subexecutive committee worked out a program of objectives as follows:

The wrecking of abandoned and obsolete machinery and equipment.

Utilization of all critical materials to the best advantage.

Minimization of waste and spoilage.

Re-use, wherever possible, of blanks, cutdowns, short ends, clippings, etc.

Selective handling and segregation of scrap and overage at the source.

Avoidance of contamination.

Speeding the return of scrap and waste materials through existing channels to mills and refineries.

To carry out these aims and objectives the executive committees recommended the following salvage procedure and methods:

1 Arrange in every plant for the appointment of a "salvage department manager," or for the delegation of some one individual in each plant to be responsible for the wrecking of obsolete machinery, equipment, etc.

2 Arrange to train men, if necessary, in the definition of scrap, its nature, its handling and its salvage.

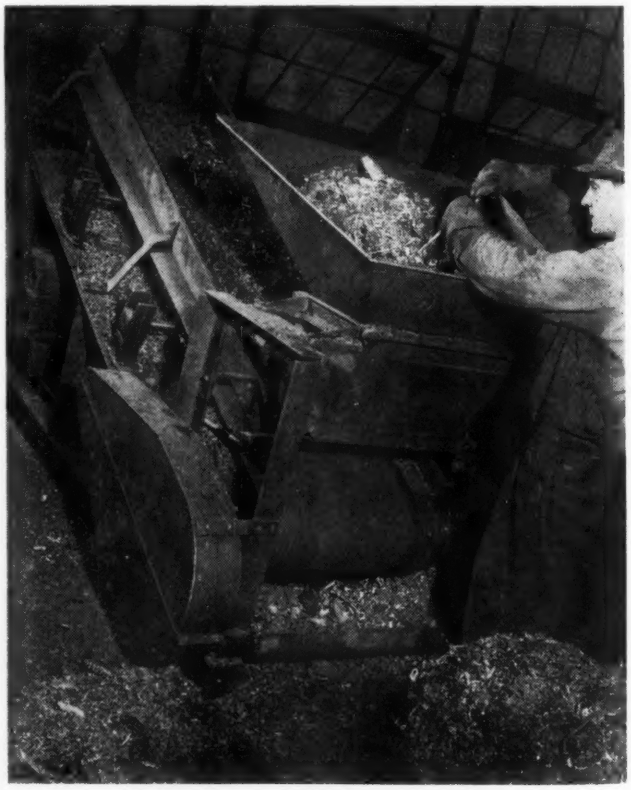
3 Arrange for a system of periodic reports (weekly reports were considered best during the early stages of the campaign) on scrap collected to be made by every plant to the executive committee.

Under the operation of the plan, the individual "salvage managers" in the various plants designate their own plant and departmental salvage committees and work out their own system of handling, reporting, etc., as well as methods to be followed in wrecking obsolete machinery, disposing of out-of-date or discontinued finished products, and other stored materials not likely to be used.

Gas Generators for Motorcars

INDIAN ENGINEERING

VARIOUS articles in the technical press indicate that considerable attention is being given in Europe to producer-gas generators for motor vehicles, and an article in the July, 1941, issue of *Bus and Coach* describes the operation, in England,



IRON RECLAIMED FROM NONFERROUS SCRAP

(Iron is removed from reclaimed metals at the Westinghouse Linhart Works, east of Pittsburgh, by a magnetic separator that "holds" ferrous materials on a conveyer belt and deposits the rest in a box. Approximately 20 tons of nonferrous ingot are produced daily from shavings, punchings, and other machine-shop remnants that come from Westinghouse plants in the Pittsburgh area, South Philadelphia, and Sharon, Pa., and Newark and Jersey City, N. J.)

of a fleet of ten passenger buses with producer-gas trailers using anthracite fuel. The following editorial is taken from the July, 1941, issue of *Indian Engineering*.

Already the use of producer gas is attracting the attention of motor-vehicle owners in India, and it is interesting to learn that great consideration is being given to this substitute for petrol in South Africa, not so much on the score of possible dislocation to be feared in the event of a petrol famine during the war, as to the fact that its use is economic at any time. The Producer Gas Commission appointed by the South Africa Union to investigate the possibilities of using producer gas as a substitute fuel for petrol vehicles has reported that producer gas is a practical substitute for petrol and the only one of immediate importance to the Union, and that there is enough surplus hardwood available to meet the fuel demand for 20,000 producer-gas vehicles, while there are also alternative indigenous fuels. The same is true of India. It is also pointed out in the report that the use of producer gas would entail the modification of petrol engines and would mean reduced speed and pay-load capacity, and additional labor. On the other hand, it is declared by those competent to judge that on balance the economy obtained makes it well worth while to convert a petrol lorry or tractor to producer-gas operation, provided that the work expected of the vehicle justifies the additional capital outlay.

We would like to have some figures relating to fuel costs and expenses incident to the running of producer-gas vehicles in India, after more comprehensive experiments have been tabulated and compared with petrol operations, but in any case they should not be greatly dissimilar to the South African results where a fifteen-hundredweight lorry running on producer gas has done 100 miles at a fuel cost of 2s 4d. A four-ton lorry used a bag of charcoal costing 2s 6d for 60 miles, while on petrol at 1s 11d a gallon the minimum cost would have been 14s 5d. A tractor can plough $2^1/_2$ acres in South Africa at a cost of 1s against 20s running on power paraffin. The Producer Gas Committee found that the use of gas means a saving of about 75 per cent in the fuel bill, and that this is enough to make conversion of vehicles economical provided the vehicles cover a minimum mileage of about 6500 a year, or approximately 18 miles daily on the average. Most motoı vehicles average considerably more than that in India, and consequently it is a paying proposition to convert, and sacrifice the extra speed of the petrol service; which as often as not is eaten up in cities and ports by traffic holdups. There would seem to be a great future in India for producer gas vehicles if the quoted running costs are compared with those in India.

Reproducing Drawings

PRESSED into 24-hour-a-day service to speed production of defense orders, a developing machine, said to be the largest of its type in American industry, is turning out 18,000 drawings daily at the works of a large electrical manufacturing company. These drawings or prints for the production of electrical equipment are produced by an original method called "Black and White (B.W.) Direct Printing Process." The 80-in. machine brings out the drawings in black lines upon white paper, developing more than 10 miles of 36-in-wide paper per month.

Recently the United States Navy shipped tracings to the plant with rush orders for 553 prints, each ranging from 13 to 25 feet in length. The completed prints weighed 200 lb and were turned out by seven men with the assistance of their mass-production machinery. Such a task, which a few years ago would have overwhelmed the reproduction division's facilities, now can be prepared for shipment within 24 hours without slackening the regular flow of work.

METAL RECLAIMED FROM FLOOR SWEEPINGS

(Pieces of metal swept from Westinghouse machine-shop floors are separated from the dirt at the Linhart Works.)

Because of its speed, this direct process promises to replace the traditional blueprint method for most jobs, in the opinion of J. J. Deller, Westinghouse engineer who was instrumental in the machine's development. This process requires 50 seconds to expose and develop a print, compared to three minutes by continuous blueprint machines. The large machine uses two gallons of water a day instead of 3600 gal required formerly, and the new method needs less floor space, less power, and costs less to operate.

In direct process, a chemically coated paper is run through the printing machines. Within the printing machine is a powerful carbon arc lamp which shines through the transparent drawing or tracing onto the coated paper. Where the light strikes the paper, the coating is dissolved, but where the lines of the tracing cast their shadows the chemical remains. This exposed paper is then fed into the developer which applies a film of developing solution to the exposed side and a small quantity of water to the unexposed side to prevent curling. The chemical coating remaining on the paper reacts with the developing solution to produce a black color and thus the lines of the drawing appear in black.

Advice on Patents

A COMPILATION of fifteen articles originally published in Allis-Chalmers *Electrical Review* appears under the title "Patent Background for Engineers" in a 54-page booklet put out by the editors of *Electrical Review*.

The articles are designed primarily for engineers and executives dealing with inventions and are written in a not-too-technical style by patent attorneys and engineers with broad experience in the subjects covered.

Forced-Circulation Boiler

On Dec. 5, 1941, following the A.S.M.E. Annual Meeting, a party of more than a hundred engineers were guests of J. V. Santry, president of Combustion Engineering Company, on a trip to inspect the large controlled-forced-circulation boiler nearing completion at the Somerset Station of the Montaup Electric Company.

This unit, of 650,000 lb per hr maximum continuous capacity at 1825 psi pressure and 960 F steam temperature at the superheater outlet, represents the first large-scale commercial application of forced circulation in this country, although more than nine hundred such installations of much smaller capacity are in service abroad.

Fundamentally, the essential difference between this unit and a conventional boiler is that the hydraulic head normally available for natural circulation is augmented by circulating pumps, operating under a differential pressure of about 50 psi between the downcomer from the upper drum and the headers at the bottom of the furnace. Furthermore, distribution of water to the various circuits is controlled by means of orifices inserted at the entrances to the individual tubes where they connect to the lower header system. The quantity of water handled by the circulating pumps is substantially in excess of the steam production and this insures wetted surfaces at all points where gas contacts the tubes. Circulation is independent of the load.

In contrast with the conventional unit having convection boiler heating surface, the heat transfer, except in the second superheater stage, the reheater, and the economizer, is all by radiation; and the employment of small-diameter tubes, of $1^1/_4$ in. diameter, assures a high degree of turbulence under the high velocities employed. This is especially important in avoiding deposits on the tubes.

Forced circulation also permits flexibility in the arrangement of heating surfaces and steam drum to meet space requirements, for the elevation of the drum is not determined by the hydraulic head, as is required to assure circulation in the case of a natural-circulation boiler, particularly where high pressures are involved.

The Montaup unit will be tangentially fired with pulverized coal from the existing storage system in the plant, with provision for the use of oil as an alternate fuel. There are 24 burners in all—three pulverized-coal burners and two oil burners in each corner and four auxiliary burners. The furnace is completely water-cooled with $1^1/_4$-in-OD bifurcated tubes and the bottom is of the continuous-slag-discharge type.

The superheater is of the two-stage Elesco type with temperature control by means of bypass dampers, and a reheater of the gas-swept type, located between the two superheater stages, reheats the steam at 372 lb from the 25,000-kw high-pressure turbine to 765 F. Beyond the reheater is an Elesco fin-tube economizer and beyond that two Ljungström air preheaters. Feedwater will enter the economizer at approximately 440 F. A Hagan system of combustion control will be employed. It is significant that this boiler occupies a space originally laid out for one third the capacity.

There are three 8-stage turbine-driven boiler feed pumps of Ingersoll-Rand design, each with a capacity of 425,000 lb per hr. Ordinarily two pumps will be in operation, but if necessary one can be speeded up to supply almost the full load re-

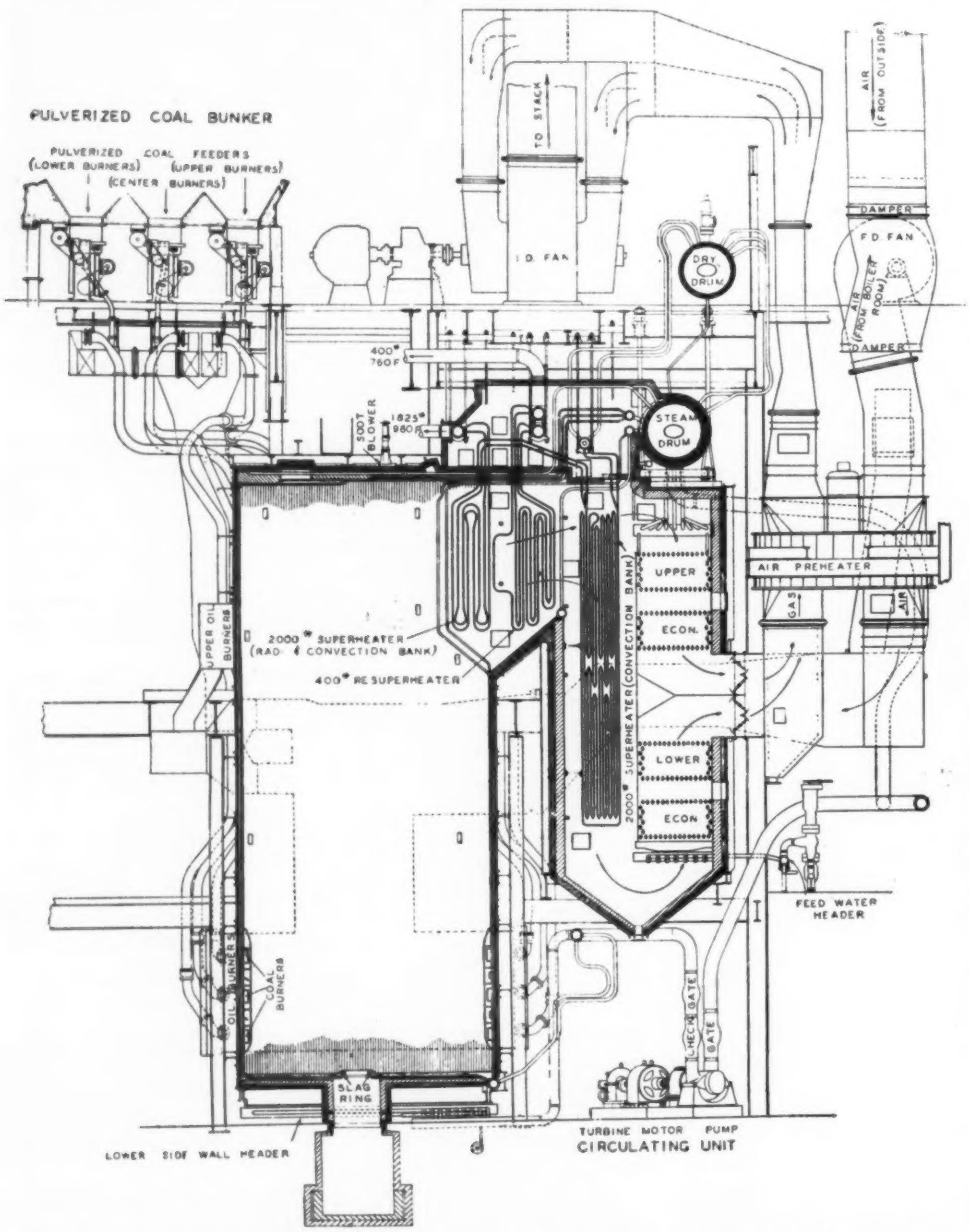


FIG. 1 CONTROLLED-FORCED-CIRCULATION STEAM GENERATOR, SOMERSET STATION, MONTAUP ELECTRIC COMPANY

quirements of the boiler. The circulating pumps, of which there are three, operating under 50 psi differential head, are also of Ingersoll-Rand design, each rated at 1,400,000 lb of water per hour. Two of these pumps have dual turbine and motor drive and the third is motor-driven.

The design of this boiler involved many unusual features of construction and erection, particularly because of the vast amount of small tubing and the number of field welds necessary, since no rolled joints were employed in the high-pressure parts. Following are some of the pertinent data:

Steam drum:	
Length, ft	43
Inside diameter, in.	54
Plate thickness, in.	$4^{23}/_{32}$
Weight, with attachments, tons	72
Furnace (completely water-cooled with continuous slag discharge):	
Width, ft	32
Depth, ft-in.	20-9
Height, ft	48
Volume, cu ft	31000
Diameter of tubes, in.	$1^1/_4$
All tubes bifurcated and connections to drums and headers welded	
Lengths of tubing:	Miles
Furnace	11.9
Economizer	2.3
Superheater	7.1
Misc.	1
Total	22.3
Number of field welds (exclusive of fittings)	2640
Water in circulating system (exclusive of economizer), gal	7800
Capacity of circulating pumps, gpm	3500
Head on circulating pumps (differential), lb	50
Time for complete circulation of water in system (2 pumps operating)	about 1 min
Power input to circulating pumps in relation to full-load plant output, per cent	0.30

An interesting comparison of weights between the use of $1^1/_4$-in. tubes and what would have been required for the same furnace with 3-in. tubes is afforded by the following:

	Forced circulation	Natural circulation	
	$1^1/_4$-in. bifurcated	3-in. bifurcated	3-in. finned
Weight of pressure parts (exclusive of superheater and economizer)	1	1.36	1.17
Weight of furnace tubes only	1	2.10	1.56
Water in furnace tubes only	1	2.74	1.77
Water in circulation (exclusive of economizer)	1	1.53	1.26
Thermal capacity of water and metal (exclusive of superheater and economizer)	1	1.46	1.23

Dual Rating of Apparatus

ELECTRICAL ENGINEERING

THE problem of suitably describing apparatus for varying-duty service has been under study by an A.I.E.E. committee for the last two years. It is of particular importance to the electrical industry because electric motors and controls are now so widely used in association with every variety of mechanical equipment to perform the varied tasks of industry. Electrical engineers have found laymen generally to be singularly impervious to ideas about temperature rise and commutation limits of electric motors; therefore, it is natural that they have sought a more generally acceptable way of defining the output limitations.

The first results of this study have recently appeared in the form of a report, A.I.E.E. No. 1A, entitled "General Principles for Rating of Electrical Apparatus for Short-Time, Intermittent, or Varying Duty." This report describes four distinct methods of rating such apparatus that are or have been frequently used, and proposes a new, or modified, "service-factor rating" method for general adoption. This method is equally suitable for rating mechanical apparatus and materials, so that its use should facilitate the coordination of all the different elements in electromechanical systems of every sort.

In Fig. 2 is shown the output-time characteristic of an electric

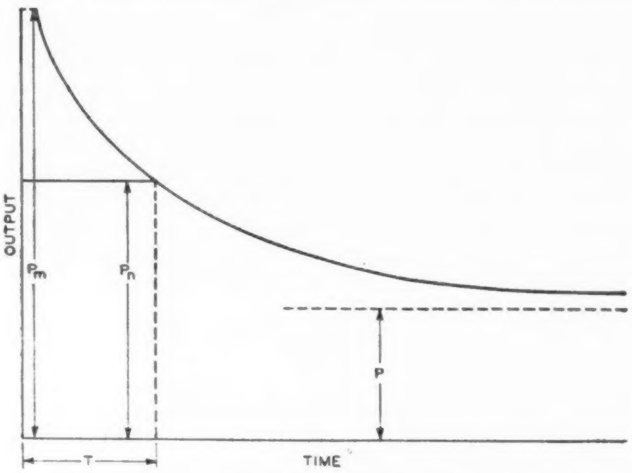


FIG. 2 OUTPUT-TIME CURVE OF AN ELECTRICAL DEVICE

P_m = maximum momentary output, fixed by other than thermal limitations

P = continuous output, or rating for continuous operation under known service conditions

P_n = name-plate rating, or sustained load that may be carried in intermittent, short-time, or other specified duty. In the case of general-purpose apparatus, P_n may be slightly less than P to provide a margin where service conditions are unknown.

T = time associated with short-time rating

S = P/P_n = service factor.

motor or other device. The maximum momentary load P_m that can be carried (say, for one minute) is governed by the strength limit, fixed by breakdown torque, commutation, voltage regulation, or the proportional limit of the mechanical structure; and the endurance limit P is fixed by the temperature, chemical stability, and deterioration rates of the materials employed.

Obviously, the sustained load on the apparatus must be considerably less than P_m, and there must be a reasonable safety margin in addition to provide for unknown conditions of service. It is desirable, therefore, to choose a name-plate rating, P_n, representative of the load that is actually to be carried for repeated or sustained time intervals. Just how P_n is determined will depend on the type of apparatus and the service. It may represent a one-hour rating, or the average of a varying load over any agreed short time interval, or simply an arbitrary fraction of the required P_m value.

The recommendations of the A.I.E.E. committee report may be summarized in a few brief statements, for all short-time, intermittent, or varying-duty apparatus (referring to Fig. 2):

1 The name-plate rating P_n should indicate the permissible frequently repeated or sustained load.

2 The momentary peak-load capacity P_m should bear an approximately constant relation to P_n, for any given type of apparatus, in associated system elements.

3 The permissible continuous load P, that may be carried for an indefinitely long period without injury, should be indicated by a service factor S less than unity, applied to the name-plate rating: $P = SP_n$.

To put these suggestions to practical use, and adopt or modify them for industry standards of rating, is a task for the future that will take considerable time.

The A.I.E.E. committee has requested comment from mechanical engineers on this method of rating mechanical apparatus particularly if they see any reason why the service-factor method cannot be applied to mechanical devices when and if overload ratings are required. The committee chairman is P. L. Alger, General Electric Company, Schenectady, N. Y.

Rotating Pendulum Detuners

PROCEEDINGS, THE INSTITUTION OF MECHANICAL ENGINEERS

CONSIDERABLE interest and much valuable discussion have been aroused by the paper "The Elements of Pendulum Dampers," by R. W. Zdanowich and T. S. Wilson, Proceedings, The Institution of Mechanical Engineers, vol. 143, June, 1940, p. 182; discussion, vol. 144, March, 1941, p. 217. A synopsis by the authors follows.

The dynamics of a rotating pendulum detuner has been treated in a completely general way, and all principal known types have been included. A new and practical method of considering the effects of a pendulum detuner, when fixed at any point in the engine system, has been developed showing that a detuner of the type described virtually behaves as a simple flywheel whose moment of interia can be varied at will to possess practically any value lying between the limits of plus and minus infinity. Consequently its action results in an alteration or displacement of the critical speeds at which the harmonic orders occur. The effects of a detuner on harmonic orders other than the design ones are also fully considered.

A convenient practical method is outlined for arriving at the best design of a detuner, irrespectively of its location or position in the engine or engine transmission system. This method successfully overcomes the numerous difficulties which were experienced by all the early designers and which were due to incomplete understanding of the general principles governing the behavior of the detuners. The method outlined also enables the designer to adopt easy machining tolerances for the various component parts, thereby allowing for the effects of wear, distortion, and thermal expansion.

As a practical illustration a brief account is given of experimental work which was undertaken to test the behavior of a well-known engine with a detuner fitted at the flywheel. This position has been chosen as being the least obvious of all for the successful application of a detuner. A further example is given of the application of a detuner to a six-cylinder in-line engine. Both examples clearly illustrate the precise agreement in all cases between experimental and calculated results.

A parallel treatment dealing with the suppression of longitudinal or axial vibrations of crankshafts is discussed in the authors' reply to the contributions. The possibilities of adopting various curved tracks for the suspension of pendulums, i.e., elliptical, hyperbolic, parabolic, and the like, in place of the customary circular ones, are also touched upon.

A convenient method for obtaining reliable results with a Geiger torsiograph is outlined together with some reproductions of actual records of torsional vibrations.

Special forms of pendulums and a note on the estimation of angular amplitudes are discussed in appendixes. A complete bibliography and a short list of the most important patent specifications relating to rotating pendulum detuners are also included.

Torque-Tube Flanges

INGENUITY of tool and die designers is reflected in a new method for fabricating steel flanges for the ends of torque tubes, developed by the Buick Motor Division, Flint, Michigan.

These flanges in two sizes are used, one at each end of the torque tube, and are simultaneously butt-welded to the ends of the tube in an electric welding machine. They were formerly made on upsetters.

In the new method a circular disk with a hole in the center is blanked from heavy-gage strip and, after annealing, the disk is forced down over a steel ball by a die, extruding the collar required for subsequent welding to the torque tube.

The larger flange blanks are of $^{9}/_{16}$-in. low-carbon steel 6 in. in diameter with a 2-in. hole. They are blanked from strip stock on a 600-ton Clearing press, annealed, and then, on a crank press, each disk is forced down over a steel ball which expands the hole to $3^{1}/_{8}$ in. and extrudes a $1^{3}/_{8}$-in. collar on the flange.

The lower die of the press is cylindrical in shape, with a hole in the center large enough to permit passage of the steel ball which rests on a tool-steel post cupped out at the top and supported inside the lower die on the pressure pad of the press. The upper die is also cylindrical and has a tapered cavity so that the formed collar is drawn down to a thickness of $^{1}/_{8}$ in. at the top. It was necessary to taper the collar in this manner to prevent the metal from opening up or cracking on the upper edge.

After the dies close to hold the blank firmly in position and centered over the ball, they start to lower and the blank is forced over the ball which, after emerging from the top die, rolls down a chute to one side. This chute accommodates four balls and feeds them one after another onto the center post, in position for the subsequent drawing operation.

One of the problems incident to development of this unique method was that of obtaining satisfactory steel balls for the forming operation. Difficulty was experienced with the flange galling during the process with the result that the steel balls picked up metal on their surface and became rough and off-size.

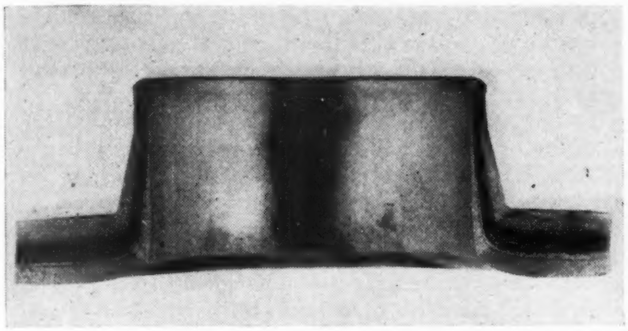


FIG. 3 ETCHED CROSS SECTION OF TORQUE-TUBE FLANGE

Chrome-steel balls were tried first, ground and polished to a high luster. Then it was decided to bonderize the surface of the balls. This proved to be an improvement over the highly polished surface, but later it was decided to change to balls of polished high-speed steel which are now giving satisfactory service.

Another problem was selection of a suitable lubricant for the forming operation. Many different types were tried, including cutting oils of various trade names, but it was finally determined that ordinary machine oil gave the best results.

New Semiautomatic Carbine

ARMY ORDNANCE

IN *Army Ordnance* for September-October, 1941, and January-February, 1942, Lieut. Col. Rene R. Studler describes the development and testing of a new light rifle to replace the pistol and submachine gun. The War Department recently has announced the adoption of this new infantry weapon. Its official name is "U. S. Carbine, Caliber .30, M1." This announcement marks the completion of exactly one year's intensive work on the part of the Army Ordnance Department, the Office of the Chief of Infantry, and several major arms manufacturers, as well as independent inventors.

The need for a new weapon for the individual soldier, one that would weigh little but hit hard, resulted from a change in tactics and was made apparent when it was seen that rear elements often became suddenly confronted by the enemy at close range. Previously, it had been found that a pistol was sufficient for personnel serving machine guns and other team-operated weapons. When the Nazi spearheads began to penetrate the Allied lines and parachutists appeared in the rear areas, the defenders had no weapons which could adequately reply to their fire.

What is needed, it developed, is a light but powerful weapon. It must be light because it must be carried by the soldier in addition to the equipment which he carries for his team weapon. Secondly, it must compare favorably with the fire power of the enemy infantry. Thus the carbine and its cartridges were conceived. The carbine is light and short for portability; the cartridge has a light bullet and high muzzle velocity for increased striking power at distances beyond practical pistol range.

Production of the carbine involved an investigation into the most intimate and basic details of gun and ammunition design. It first was necessary to design a cartridge to meet the ballistic requirements. This was completed in December, 1940.

The original specifications prescribed a rifle capable of automatic fire, but a study of the preliminary tests indicated that because of the light weight, all the guns showed considerable "climb" when fired at full automatic. It was therefore deemed advisable to remove the requirement for full-automatic fire and to make the rifle strictly a semiautomatic type.

September 30, 1941, exactly one year after the initial announcement, the subcommittee charged with the selection of a light rifle convened. The report of the test board was presented, discussion of its findings ensued, and doubtful or unfamiliar points were cleared up. Finally, agreement was reached as to last-minute, perfecting modifications, and with unanimous agreement the Winchester entry was recommended for adoption.

Later the same day, a special meeting of the Ordnance Technical Committee was held, and the findings of the subcommittee were presented. The findings were received and approved, and a new Army team, carbine and cartridge, was recommended to higher authority for approval. This necessary clearance was soon obtained, and the development and experimental phases were completed. With the adoption of the carbine and its inclusion in the Ordnance Department's Book of Standards, the work is not finished. Facilities for its manufacture must be provided, production schedules must be worked out, and the necessary raw materials assembled.

This work is continuing at the rapid but careful pace which marked the development. Already tooling is under way and contracts for manufacture are being negotiated. Within weeks of the date of standardization, five production models of the carbine were delivered to the Chief of Ordnance. These guns

FIG. 4 WINCHESTER SEMIAUTOMATIC CARBINE, CALIBER .30, M1
(Length 35 in., 18-in. barrel, weight 4.6 lb without magazine or sling, gas-operated.)

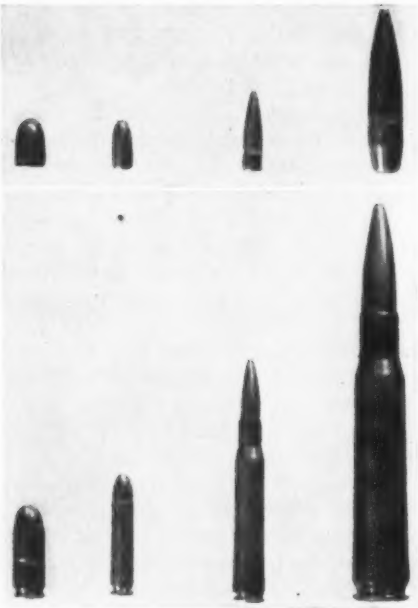


FIG. 5 COMPARISON OF SMALL-ARMS AMMUNITION
(Bullets at top, cartridges at bottom; left to right, Caliber .45 ball; Caliber .30 SR, M1; Caliber .30 M2; Caliber .50 M2.)

will be checked against production drawings and thereafter will be subjected to extensive endurance tests. The tests will provide the basis upon which maintenance procedure, training manuals, and other necessary data will be based. Thus, the announcement of standardization is not the end of the story. The main activity has but shifted from the Army to American industry; it now has the task of producing America's latest and handiest weapon for the individual soldier.

Electrolytic Polishing Cell

METAL PROGRESS

IN AN article in *Metal Progress*, September, 1941, O. E. Brown and C. N. Jimison give the basic requirements for the successful electrolytic polishing and etching of metallurgical specimens, and describe suitable apparatus for the purpose. According to the authors the most important basic requirements are as follows:

1 The current density on the specimen should be accurately controlled, since the satisfactory range for most metals is narrow.

2 The specimen must not be in contact with the electrolyte except when the current is flowing.

3 The specimen should be washed and dried immediately following treatment; this requires that the specimen be easily and quickly removed from the apparatus.

4 The position of the specimen during polishing or etching should be fixed so that no unnecessary variable (of internal resistance) will be introduced.

5 The temperature of the electrolytic bath should be easily controlled.

Fig. 6 shows a cell which is said to satisfy all of these requirements. It will be noted that the round specimen or its mount forms the closure for the opening in the end of the tank and is held tightly in place by a spring clip which also makes the electrical contact. This means of holding the specimen has the double advantage of speed (the sample can be rapidly inserted or removed) and of limiting the attacked area to that of the opening. Current density can therefore be accurately controlled.

The cell has a rectangular shape and, for microscopic specimens, can be rather small. Satisfactory results have been obtained by the authors with a wooden box 2 in. wide, 3 in. deep, and $3^1/_2$ in. long. The hole which the specimen covers is $^1/_2$ in. in diameter, although this can be made any size which the operator may prefer. The inside of the container is coated with paraffin. It should be mentioned that bakelite is not to be used where it will come in contact with the electrolyte, for at least one of the electrolytes commonly employed for electrolytic polishing attacks bakelite and will be rendered unusable by a bakelite container or mount for the metallic specimen.

The cell as shown does not have any provision for regulating the temperature. In most instances the temperature of the electrolyte does not vary sufficiently during the preparation of a specimen to warrant any special control. However, when several specimens are to be prepared in rapid succession it is recommended that a U-tube containing circulating cold water be inserted in the cell to prevent temperature rise. It has been found that a mechanical stirrer is not satisfactory, for any forced motion of the electrolyte will cause an uneven attack on the metal surface and give a rippled effect.

There is no contact between electrolyte and specimen when the tank is in the tilted position. The operator is free to insert the specimen in place and see that it is firmly seated without any contact with the electrolyte whatsoever. When the tank is raised to the operating position, the electrolyte covers the metal, thus closing the electrical circuit. This fully satisfies the second requirement.

Removal of the specimen is quickly accomplished by touching the toggle joint and, as the tank lowers, the specimen is taken from beneath the clamp. It is advisable to have running water at hand so that a thorough washing of the polished metal surface may be accomplished immediately.

If such a procedure is followed, the mechanical difficulties usually encountered in electrolytic preparation of specimens will be eliminated.

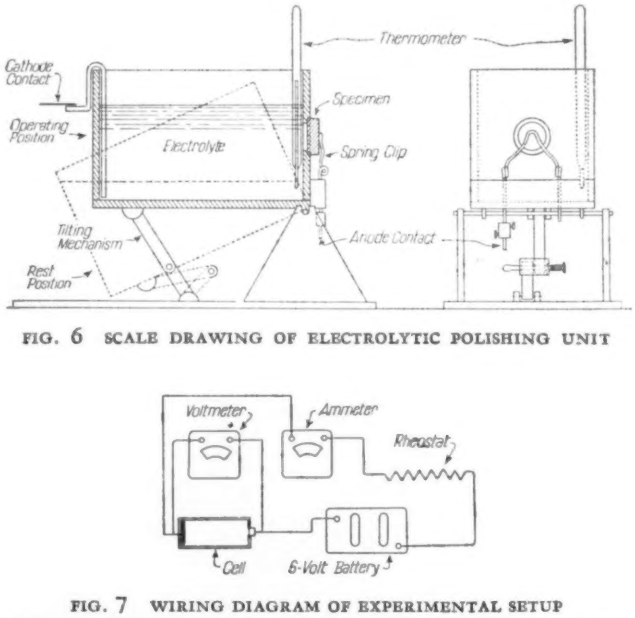


FIG. 6 SCALE DRAWING OF ELECTROLYTIC POLISHING UNIT

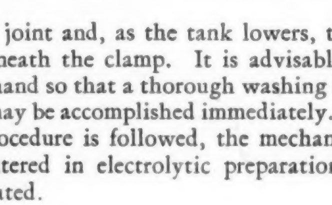


FIG. 7 WIRING DIAGRAM OF EXPERIMENTAL SETUP
(After proper conditions are discovered, repetitive work can be done merely by setting rheostat for correct resistance.)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Engineering Curricula

Comment by F. O. Ellenwood[1]

This paper[2] is, in the opinion of the writer, both interesting and stimulating to most of us who are engaged in teaching mechanical engineering. The suggestions for a guide in our future curriculum building appeal to the writer as being basically sound and appropriate. These suggestions also serve to indicate how some of our present courses may be broadened to yield the utmost in educational value to our students of today.

The writer is entirely in accord with the author's belief that fluid flow and heat transfer are of far greater importance than the conventional course in hydraulics which may well be eliminated, as he suggests, without shedding a single tear, if time does not permit the inclusion of all three subjects.

The author refers to thermodynamics as a "major background study;" and the writer believes that no one questions that statement as applied to the curriculum for mechanical-engineering students. For other engineering students, however, some members of the mechanical-engineering staff are generally expected to give one or more short courses pertaining to heat engines. Just what material should be given in such courses is often a matter which involves some differences of opinion. The writer believes that these short courses should also include considerable basic thermodynamic training; for such a training, even in one short course, will usually go much further toward helping students with their later problems than will an equal time spent exclusively in studying certain types of engines which may happen to be popular at the time the student is in college.

Comment by H. P. Hammond[3]

In general the writer agrees with the remarks and arguments in this paper, though he would point out one important precaution, namely, that, in the effort to define the basis on which mechanical-engineering curricula should be built, we should avoid rigid standardization and adherence to a particular pattern, either of curriculum or of instruction. Far too many engineering curricula of our American schools follow a conventional arrangement and embody purely conventional courses and subject matter. The author's proposals, as embodied in the second part of his paper, are a departure in some respects from the usual pattern and, therefore, the writer judges that he does not intend to recommend the uniformity which is to be feared. Nevertheless, it is well to keep this danger constantly in mind and to remember that the effect of any accrediting procedure is likely to be in this direction. E.C.P.D. has been unusually broad in its attitude on this question; in fact, has not only stated but followed as a practice the accrediting of sound curricula if administered and taught according to good standards even when these curricula do not conform to a preconceived pattern or set of rules. It seems to be one of the most wholesome things in engineering education that the accrediting procedure of E.C.P.D. should follow this principle and should have the objective of promoting experimentation and originality in engineering education.

The writer is particularly interested in one or two of the author's proposals, especially that the standard course in inorganic chemistry be replaced by an elementary course in physical chemistry. He should like very much to see the syllabus of such a course and to know whether it is actually in operation. The suggestion is a most inviting one, although the question arises as to how such a course can be presented without first giving the student knowledge of the elements, compounds, reactions, and chemical laws which constitute the ordinary first course in inorganic chemistry. If this can be done and if, at the same time, the principles of physical chemistry can be taught without making the course superficial, it would seem to be a distinctly valuable innovation in engineering education.

Comment by A. L. Williston[4]

The reference made by the author to Dr. Arthur Little's formula of "unit operations" is interesting, and, yet there is nothing especially new in its principles. Dr. Little in his formula has simply analyzed and subdivided the new subject matter of a complicated field of engineering into teachable units in much the same way that the mathematician does when he subdivides the broader field of mathematics into algebra, geometry, trigonometry, etc.

As a matter of fact, however, in the older field of mechanical engineering, this principle has perhaps already been carried too far. In areas of instruction such as Professor Church's analytical mechanics or in thermodynamics the "unit" ideas have been so segregated and removed from their application very often as to kill interest and understanding of their true value and usefulness in creative engineering.

But how futile to think that engineering education, or any other education, for that matter, can be materially improved by attack upon the curriculum alone, without first taking into consideration the entire pattern of attitudes, abilities, backgrounds, and probable ultimate goals of the human materials for which our schools are accepting responsibility!

For example, we as engineers have long been heartily ashamed of our records of graduating, within the allotted 4 years, but roughly one fourth of the number of students whom we enroll in the freshman class; and in many instances of doing incalculable injury to a large proportion of those for whom we have accepted a sacred obligation; and all of this because of our own inexcusable failure. Our sins of omission should lie very heavy on our hearts and consciences.

Decade after decade we allow this to continue, because of our interest in the subject matter with which we are dealing, and an almost total disregard of the related human factors involved in maturing promising material into professional competency.

Two generations or more ago engineering education was in the lead. It ushered in a great advance in education. Indivi-

[1] Professor, Heat-Power Engineering, Cornell University, Ithaca, N. Y. Mem. A.S.M.E.

[2] "A Suggested Design for Mechanical Engineering Curricula," by F. L. Wilkinson, Jr., Mechanical Engineering, August, 1941, pp. 581–584, 599.

[3] Dean, School of Engineering, The Pennsylvania State College, State College, Pa. Mem. A.S.M.E.

[4] Dedham, Mass. Mem. A.S.M.E.

dualized instruction through the laboratory method; first-hand contact with the realities of the situation; and self-discovery of principle by inductive analyses was the rule. And "creative action" not "passive receptivity" was the procedure used to stimulate both enthusiasm and understanding and to foster the growth of personality.

Since those early days, the subject matter has become more and more complicated and engineering education has continuously gone backward. While we have been witnessing great advances in other fields of professional education, notably in law, through the introduction of the case system of instruction, and in medicine through the more general use of clinic and individual laboratory investigation, we have been content to watch in our own field a continued retrogression.

Not until there is a very genuine "conviction of sin" on our part can we hope for any material improvement! Not until that hour arrives can we expect really to go forward! Then perhaps we will be willing to give the same kind of scientific study to all the elements of our problems of education which we now give to the solution of our professional engineering difficulties.

When that hour arrives, we will study critically human capacities and individual differences and the procedures for creating incentives and enthusiasms; measure the maturing influence of each of our procedures toward any desired goal; and know the goals of competency toward which we are aiming. Then we will have more complete and more rational specifications for our whole problem. We will be eager for all the help that educational research can give, and there will rapidly begin the elimination of the shocking human waste that is almost universal today.

COMMENT BY THEODORE BAUMEISTER[5]

It was stimulating and pleasing to study the author's proposed design for mechanical-engineering curricula.

Several years ago, it was recognized at Columbia University that the old prevalent empiricism of the mechanical-engineering profession had resulted in the growth and use of a curriculum that was both cumbersome and outmoded. Under the leadership of Dr. Charles E. Lucke, then Stevens Professor of mechanical engineering, the old courses were entirely abandoned and a new curriculum established. The motives behind the new curriculum and the arrangement of the subject matter were presented in a paper[6] by Messrs. Eidmann, Shoudy, and Baumeister.

The program outlined by the author recognizes similar problems and leads him to conclusions which are largely identical with the conclusions reached at Columbia University. A study of the chart, given in the paper, and Fig. 1 of this comment, reveals the numerous similarities.

The Columbia University program has now been in use for 7 years, and the results have justified the abandonment of the older curriculum. Some few alterations have since been made as a consequence of experience, but the basic concepts, reflected in the figure, have been retained.

The question of proper training in chemistry for mechanical engineers has been difficult of solution. The chemistry curriculum in most schools follows a pattern which is the same for all kinds of students—engineers, medical doctors, biologists, scientists. There is a readily recognized sequence of (1) general inorganic; (2) qualitative; (3) quantitative; (4) organic, etc. As the author points out, this pattern is not suitable for the education of mechanical engineers, unless the training period is unduly extended.

A new type of "general chemistry" courses is needed, which will cover such subjects as: (1) Chemical elements and compounds, their reactions and heats of reaction; (2) analytical, physical, and thermochemistry; and (3) the chemistry of important engineering substances, such as, water, fuels, lubricants, cements, and metals. It is to be hoped that this paper will stimulate the necessary development.

[5] Professor and Executive Officer, Department of Mechanical Engineering, Columbia University, New York, N. Y. Mem. A.S.M.E.

[6] "A New Curriculum in Mechanical Engineering," by F. L. Eidmann, W. A. Shoudy, and T. Baumeister, Jr., MECHANICAL ENGINEERING, vol. 57, 1935, pp. 483–485.

FIG. 1 SEQUENCE OF COURSES OFFERED BY THE DEPARTMENT OF MECHANICAL ENGINEERING, COLUMBIA UNIVERSITY, SCHOOL OF ENGINEERING

At Columbia University, it has been necessary to ask the chemical-engineering department to offer two new courses, especially for mechanical-engineering students, on (1) industrial chemical calculations, and (2) chemical properties of engineering materials. These offerings have been of assistance, but a more effective solution of the problem could be obtained if the trouble were corrected at the source, the freshman and sophomore chemistry courses.

The blind use of formulas by students continues as a bothersome problem. It is difficult to have students live and feel the laws of Nature which are often so conveniently expressed in algebraic and graphic form. The student glibly uses terms, names, and symbols, such as, Boyle's law, Hooke's law, Reynolds number, enthalpy (never heat content—sic!), reversibility, and thinks he is skilled in the art. He develops a worship of symbols, which is blind and almost fanatical at times.

Separate economics courses for mechanical engineers are desirable. However, the economic picture should not be limited to those distinctly economic courses. All courses, all topics, all periods in an engineering school should be a continuing reminder to the student of the cost elements. The student should at all times see the subject of study through an economic screen. The view should be similar to a stage setting wherein the backdrop is science and technology, but the backdrop can only be viewed through the theatrical gauze curtain of economics. This filtered view is truly engineering, and, in the long run will be most effective in driving home the economic lessons which are so necessary.

COMMENT BY O. F. ZAHN, JR.[7]

Speaking solely as a former engineering student who by now has had about 10 years' experience as a practicing engineer, the writer wishes to express his admiration for the excellent suggestions the author has made for a modernized mechanical-engineering course. Our courses need organizing along the lines of basic "engineering sciences," as the author calls them (fluid flow, heat transmission, etc.).

Specifically, the writer would favor more emphasis on a study of combustion than is indicated in the paper. Combustion is at once a basic science and a highly individualized art. In general chemistry courses, combustion is treated as "just another reaction," which to the scientist it is. To the mechanical engineer combustion is a phenomenon which is far more important than all other branches of chemistry combined. Combusion of gasoline and Diesel fuels in internal-combustion engines, boiler fuel oils, gas, and coal in steam power plants are all carried out in diverse ways. In each case, the same fundamental principles are involved. A study of this subject might well be substituted for some of the more specialized courses on power plants, automotive engineering, etc., which are now offered to students.

[7] Martinez, Calif. Jun. Mem. A.S.M.E.

Analysis of many engineering problems shows them to be related to those in other fields. The problem of speed flexibility in power plants, for example, has resulted in the variable-speed transmission, resulting further in such diverse applications as the variable-pitch propeller, the three-speed gear transmission, the hydraulic transmission, the electric drive, etc. Power plants themselves have also been made more flexible, hence we have the automatic spark advance, the dual-jet carburetor, the closed fuel-injection nozzle, etc. Another common problem in power plants is operating economy at varying outputs; hence the needle-type nozzle for hydraulic turbines, the "wide-range" fuel burner for boilers, the manifold-controlled spark advance, etc. This is not to suggest that colleges offer such a course as, "Engineering Ingenuity in Common Problems," but rather that such similarities be kept in mind in the presentation of the existing courses. The writer personally feels such comparisons are a source of inspiration to an engineer.

Not all engineering education should be a unification of existing arts and sciences. In many cases, college training has not paid enough attention to specific contrasts. Thermodynamics, for example, in the undergraduate courses treats all heat engines alike, yet in the further study of specific engines the student finds the internal-combustion type using air for a working medium and, in the externally fired engine, he finds water used as the medium. Each type is perhaps in itself thoroughly studied, but they are not sufficiently contrasted with each other. As a result, few graduates can answer the question satisfactorily: "Why not use air instead of water in boilers?" or, "Why not use water injection in gasoline engines?" A better grasp of the principles of the two types of engines would result if texts included contrasts such as these in their discussions.

Much of the foregoing applies in some respects to the organizations of the engineering societies, for they constitute one of the principal sources of education to the engineer after graduation. It is the writer's understanding that the question of organizing professional divisions according to basic sciences or to industries is an old one. It may not be amiss, however, to re-examine this question from time to time. Fluid flow, for example, is the subject of many technical papers presented in several of our own professional divisions. Very wisely, distribution of technical papers to each member is no longer confined to the three divisions in which a member may be registered. To assist each member in determining his interest in a paper, we might go even further and classify many of our papers according to an "engineering science" designation. In any event patterning A.S.M.E. educational material after that which the college student sees in school will assist him in making the transition into industry and, in general, open the way for him to continue his education effectively.

AUTHOR'S CLOSURE

It is most gratifying that the splendid discussions of this paper have emanated from both practicing engineers and educators. It is only through the joint efforts of educators and practitioners that the educational process may be improved. The author wishes to express his gratitude to those whose discussions are published herewith.

Professor Ellenwood very wisely suggests that we should look critically upon the "short courses pertaining to heat engines," offered to non-mechanical-engineering students. The author agrees that these courses should be so designed as to include more "basic thermodynamic training," rather than simple descriptive material dealing with certain types of popular engines. To do otherwise is likely to place the treatment of heat engines perilously near the vocational level.

Dean Hammond's warning of the dangers of "rigid standardization," and "adherence to a pattern" in engineering education is not only well taken, but timely. However, adoption of certain principles, upon which mechanical-engineering curricula may be designed, does not imply rigid standardization. The curriculum outline is suggested more as a sample method than as a pattern to be followed. It does advocate emphasis on certain fundamentals to be offered, in many instances in lieu of specialized subjects which tend to build walls around much scientific knowledge, thus limiting their usefulness, in the students' minds, to those fields of application in which they are introduced. This principle should

be the basis for engineering education in all its branches, the division being only in the applied fields that are syntheses of the engineering sciences. The author agrees that the broad attitude of E.C. P.D., toward evaluating engineering curricula, is not only wise but effective in stimulating initiative and progress in engineering educational programs. The S.P.E.E. Committee on Aims and Scope of Engineering Curricula,[8] of which Dean Hammond was chairman, has performed an excellent service in outlining a general principle or policy for all engineering education. Thus, a general guide for engineering education as a whole has been established. This should be carried further and principles established in each of our educational divisions that may serve as guides in the design of curricula in each field.

The author agrees with Mr. Williston that the "unit ideas have been so segregated and removed from their application very often as to kill interest and understanding of their true values and usefulness in creative engineering." In fact, it was the author's wish that his paper would tend to call attention to this fact. The "unit idea," as suggested by Mr. Williston, is quite at variance with the idea of education along the lines of "principal practices," which may be synthesized into the many applied fields of engineering. The idea, as proposed, is that "principal practices," such as those outlined in the "Machine Design Group" and the "Energy Transformation Group," are syntheses of the "Engineering Sciences," and they in turn must be recognized as contributing to the practices of mechanical engineering in the applied fields. If these "principal practices" are taught too objectively, we stifle creativeness, and Mr. Williston's warning is quite timely and needs additional emphasis.

Mr. Williston's comments should be read and taken to heart by all engineering educators. They are particularly pertinent, since they may be considered as being the reflections of one whose background and experience in engineering practice can call critical attention to our shortcomings.

Mr. Zahn, after 10 years of practice since graduation, calls attention to one of the interesting divisions of thought in the pedagogy of teaching the "engineering sciences." This group of scientific subjects is usually taught by engineers and it is generally agreed that this is as it should be. The division of pedagogical thinking, however, is emphasized in the departmental treatment of these subjects. One group insists that each degree-granting department should teach them as they apply to its own field, and we find thermodynamics taught departmentally by the mechanical engineers and the chemical engineers. A recent excellent text on the subject was published with the bold title "Thermodynamics for Chemical Engineers." The other group is much more liberal perhaps and expresses the opinion that the engineering sciences should be taught alike to all those whose practices may be based on these sciences. Thus, thermodynamics for mechanical engineers is the same as thermodynamics for chemical engineers.

The author feels that the adoption of the second pedagogical principle by all engineering schools would tend to create much more versatile engineering graduates and might go a long way in solving some of the very pertinent critical comments which are suggested by Mr. Zahn.

The curriculum outline offered by Professor Baumeister, from the paper[6] by Eidmann, Shoudy, and Baumeister, is of extreme interest in this discussion, in that it presents a curriculum with unusual emphasis on the "principal practices." Its success after 7 years in practice at Columbia University substantiates the soundness of the principles involved. It is interesting to note that, in conducting the new curriculum at Columbia, the department of chemical engineering was called upon to supplement the general chemistry course offered in the college. This is an important point, and too much emphasis cannot be given to the importance of the course contents of the natural-science subjects taught to engineers. This is especially true of physics and chemistry. The mathematicians have generally accepted this thesis, but the chemists and physicists have still to be reckoned with.

In answering the comments of Dean Hammond and Professor Baumeister on the elementary course in "theoretical" or "physical" chemistry, the author has enlisted the services of Dr. R. C. Ernst, head of the department of chemical engineering at the University of Louisville. The course as given for freshmen students at that institution is now in evolution and the outline given here contains much of the material now offered. Its objective is to provide background material for the study of engineering sciences. Dr. Ernst's suggested syllabus in brief is offered here at the risk of extending this discussion beyond its allowed length.

A COURSE OUTLINE FOR FRESHMAN THEORETICAL CHEMISTRY FOR ALL ENGINEERING STUDENTS

1 *Atomic Structure.* Structure as related to the periodic relationships of the elements with especial emphasis on valence and valence types.

2 *States of Matter:*

(*A*) *Gaseous.* Density, viscosity, compressibility, vapor-pressure, and boiling-point relationships. The laws of Boyle and Charles and the combined laws. Graham's Law. Deviations from the gas laws. Temperature scales, molar relationships, Avogadro's Hypothesis, and the Kinetic Theory. The properties and preparation of gases. Equations as an interpretation of weight, volume, and energy relationships, and as a basis for heat and material balances.

(*B*) *Liquid State.* Density, viscosity, surface tension, molar quantities, vapor pressure, critical state, heat of vaporization, and relation to gaseous state.

(*C*) *Solid State.* Tensile strength, hardness, ductility, malleability, heat capacities, crystallographic systems, and law of definite and multiple proportions.

3 *Solutions.* The nine possible solutions based on three states of matter. Solvents, solute-solubility, molar, and normal. Henry's Law and Raoult's Law. Osmosis. Water and its properties.

4 *Weight and Energy Balances.* The equation and its further interpretation and use with thermal data. Heat capacities, heats of reaction, and combustion.

5 *Oxidation and Reduction.* A general treatment with emphasis on electron exchange and the writing of equations.

6 *Ionization.* Experimental evidence leading to present concepts. Acids, bases, and salts.

7 *Chemical Equilibrium.* Reaction rates and Mass Action Law. The equilibrium constant, Le Chatelier Principle, ionic equilibrium, activity, hydrolysis, ionization constant, the hydrogen ion, and its application.

8 *Sulphur.* Its occurrence and properties. The compounds of sulphur with emphasis on sulphuric acid.

9 *Nitrogen, Atmospheric.* Occurrence and properties. Nitrogen cycle. Com-

[8] "Report of Committee on Aims and Scope of Engineering Curricula," *Journal of Engineering Education*, vol. 30, no. 7, 1939-1940, pp. 555-566.

pounds with emphasis on nitric acid and ammonia.

10 *Colloidal State of Matter.* The Disperse System. Properties with emphasis on nomenclature.

11 *Electrochemistry.* Classification, including the properties of conductors, Faraday's Laws, E.M.F., polarization, overvoltage primary and secondary cells.

12 *Carbon.* Especial emphasis on a study of functional groups.

13 *Periodic Study of the Elements.* A general study of the entire periodic table. Typical elements of each group presented and the physical, chemical, and group relationships emphasized.

14 *Materials of Engineering:*

(*A*) Metals.
(*B*) Nonmetals.
(*C*) Cellulose products.

Instruction consists of lectures, quiz and problem sessions, and one laboratory period per week with an equivalent of 5 credit hours each semester for two semesters. As previously stated, this course is in a state of evolution at the University of Louisville, but has been given essentially as described for the last 2 years. As a test of its effectiveness, freshman engineering students have taken the American Council on Education Cooperative Chemistry Tests upon completion of the course. The fact that the classes completing the course have as a whole placed well above average is considered as evidence that it is not a superficial one.

The author wishes to thank the discussers for their valuable contributions.

F. L. WILKINSON, JR.[9]

[9] Dean, Speed Scientific School, University of Louisville, Louisville, Ky. Mem. A.S.M.E.

Deficit Spending and National Income

TO THE EDITOR:

The reading of Horace C. Buxton's review[10] of the Villard book on "Deficit Spending and the National Income" leaves the impression that Villard's remedy for depressions, in which Buxton seems to concur, is bigger and bigger deficit spending during recovery as well as depression, paying off the deficit by further borrowing, and so on ad infinitum, or else deficit spending coupled with recovery of the bonds from the "hoarders" by increased taxation. In other words, no incentive is to be left for saving and, in view of excessive and discriminatory taxation, little incentive is left for investing.

Without attempting to penetrate the maze of sophistry from which this gem of economic thought emerges, it may be pointed out that during the past ten years deficit spending has amounted to about a third of the capital now invested in industry in the United States, but that at the same time we have had little or no gain in permanent wealth or in income. Also, that in addition to what has been borrowed for deficit spending, taxes take $3 for every $2 that goes to the taxpaying shareholder, amounting, indeed, to one third to one half of what goes to the worker. One great fault of government spending, whether deficit or taxsupported, is that it is almost invariably wasteful.

The verbal smoke screens emitted by such as Villard and Buxton seemingly merely cover more or less complicated and covert plans for robbing some for the benefit of others, and generally without intelligent regard to the permanent effect upon the general well-being. Politicians and their bureaucratic satellites support the doctrine of "from each according to his abilities and to each according to his needs," for the reason that it is a serviceable device for catching votes, and regardless of the fact that its biological effect is merely to subsidize unlimited breeding of the improvident, the incapable, and the dishonest at the expense of those who work and save in the hope of enjoying the fruits of their labor and foresight, but who, as things are now going, are faced with the dilemma that if their ventures result in loss, they lose; while if there is gain, the taxgatherer will take it.

It is generally true that money or credit is hoarded only when the expectation of profit is exceeded by the risk of investment. In a free and open market the wages for services and interest on capital will automatically adjust themselves to demand, based upon the free choice of the consumer, and we should strive to re-establish such freedoms rather than to devise further ingenious instruments of coercion and robbery by taxation.

GEO. H. GIBSON.[11]

[10] "Spending Our Way to Prosperity," MECHANICAL ENGINEERING, November, 1941, pp. 815–816.

[11] Geo. H. Gibson Co., New York, N. Y. Mem. A.S.M.E.

TO THE EDITOR:

Thank you for the copy of Mr. Gibson's letter commenting on my review in the November issue of MECHANICAL ENGINEERING. It pleased me in that it indicates at least one person has read the article, but it also disturbed me because I feel that it misinterpreted the positions taken by me, by Dr. Villard, and by this department.

I do not believe in "bigger and bigger deficit spending" nor in "paying off the deficit by further borrowing." Will not a re-reading of my review reveal that I have presented my own opinions in only three places? (1) I state my opinion that it would be difficult to single out hoarded funds for taxation. (2) I state my belief that the recession of 1937 was associated with the 1936 curtailment of government spending and that the subsequent expansion of defense spending is a cause of present business activity. (3) I state my belief that diminution in the rate of growth of population tends toward secular stagnation even though I criticize the extreme position taken by Professor Hansen. In view of this fact, has the letter interpreted my position fairly?

Though Dr. Villard did take a positive stand for cyclical deficit spending, he gave no indication in his book whether or not he actually favored secular deficit spending. Is it just to criticize a man for views attributed to him which may not be a part of his economic philosophy at all?

The implied criticism of this department is in my opinion most unfair. The department of economics at M.I.T. does not use the columns of MECHANICAL ENGINEERING to air its own views. Reviewers are limited to books actually published. This department limits its choice among publications by only three tests: (1) Books must be recently published. (2) They must deal with current economic problems. (3) They must be significant for engineers. After a book has been selected, we try to summarize its contents fairly. We recognized when we undertook the task that there might be danger of offending some readers. It is chiefly for this reason that we limit our own comments so rigidly.

Occasionally, a meretricious work is reviewed for criticism; but the usual purpose of a review is to present in outline what some thoughtful author is now saying. Members of this department have on occasion reviewed favorably books whose conclusions differed from their own. We demand that an author shall be competent in his field; we do not demand that his opinions shall coincide with our own.

H. C. BUXTON, JR.[12]

[12] Department of Economics, Massachusetts Institute of Technology.

A.S.M.E. BOILER CODE

Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from anyone interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in small capitals; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PAR. UA-18. Revise to read:

UA-18 Scope. (*a*) Bolted flanged connections, if of steel or cast iron, conforming to the several American standards as given in Tables UA-1 and UA-2 for steel, and Tables UA-3 and UA-4 for cast iron, should be used for connections to external piping and may be used for other flanged connections. When used for external pipe connections such flanges, if of steel, shall not be used for pressure-temperature ratings exceeding those given in Table UA-5.

(*b*) Bolted flanged connections other than those meeting the requirements of (*a*) above shall be designed in accordance with the rules given in Pars. UA-19 to UA-23. These rules may be applied to flanges of any diameter, but are not intended for flanged connections having gaskets beyond or extending beyond the bolt circle. These rules shall not be construed to prohibit the use of flanges having gaskets beyond the bolt circle or other types of bolted closures, particularly those used for service at very high pressures, provided they are designed in accordance with good engineering practice.

PAR. UA-19 is to be revised. Recommendations will be submitted later.

PARS. UA-20 to UA-24. Replace by the following:

UA-20 Bolt Loads. (*a*) Minimum required bolt load W_m. The minimum bolt load in pounds shall be determined from the greater of the values obtained from formula (1) under maximum operating or working conditions, and formula (2) under atmospheric temperature conditions without consideration of internal pressure.

TABLE UA-7 GASKET MATERIALS AND CONTACT FACINGS

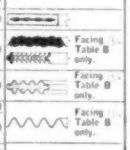
GASKET LOAD
1. TO YIELD GASKET.
2. TO MAINTAIN REQUIRED MINIMUM UNIT PRESSURE ON GASKET.

$H_{G_y} = b\pi G_y \frac{S_{cd}}{S_{at}}$

$H_{G_p} = 2b\pi Gmp$ FOR OPERATING CONDITIONS.

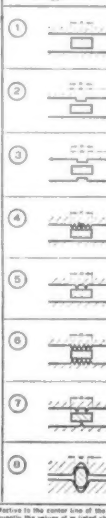
NOMENCLATURE
H_{G_y} = YIELD GASKET LOAD .... POUNDS (MINIMUM LOAD IRRESPECTIVE OF INTERNAL PRESSURE) } VALUES USED ON CALCULATION SHEETS.
H_{G_p} = PRESSURE GASKET LOAD .... POUNDS (REQUIRED TO MAINTAIN MINIMUM UNIT COMPRESSION FOR A TIGHT JOINT)
G = MEAN DIAMETER OF GASKET .... INCHES.
y = YIELD POINT OF GASKET MATERIAL .... LBS. PER SQ. IN.
b = EFFECTIVE GASKET YIELDING WIDTH .... INCHES (WIDTH TO WHICH UNIT LOAD = y MUST BE APPLIED TO SET GASKET) } TABLE B.
2b = EFFECTIVE GASKET PRESSURE WIDTH .... INCHES (WIDTH TO WHICH UNIT LOAD = mp MUST BE APPLIED FOR A TIGHT JOINT)
m = UNIT GASKET COMPRESSION FACTOR .... TABLE A.
p = INTERNAL PRESSURE .... LBS. PER SQ. IN.

TABLE A
GASKET FACTORS (m) FOR OPERATING CONDITIONS. YIELD POINT y



GASKET MATERIAL		GASKET FACTOR m*	YIELD POINT y	SKETCH AND NOTES
A. GUM RUBBER SHEET		.50	500	
B. CLOTH-INSERTED SOFT RUBBER, OR HARD RUBBER SHEET		.75	750	
C. CLOTH-INSERTED HARD RUBBER		1.00	1 000	
D. VEGETABLE FIBRE SHEET (Hemp or Jute)		1.50	2 000	
E. COMPRESSED ASBESTOS, OR ASBESTOS COMPOSITION		2.50	4 500	
F. WIRE MESH REINFORCED ASBESTOS		2.50	4 500	
G. CORRUGATED METAL, ASBESTOS INSERTED, OR SPIRAL-WOUND METAL, ASBESTOS FILLED		2.50	4 500	Facing Table B only.
H. CORRUGATED METAL JACKET, ASBESTOS FILLED		3.00	6 000	Facing Table B only.
J. CORRUGATED METAL	a) Copper	3.00	6 000	Facing Table B only.
	b) Monel c) Iron d) Soft Steel	3.25	7 000	
K. FLAT METAL JACKET ASBESTOS FILLED	a) Aluminum b) Copper	3.25	7 000	
	c) Monel d) Iron e) Soft Steel	3.50	8 000	
	f) 4-6% Chrome g) 11-13% Chrome h) KA2S j) Type 316	3.75	9 000	
L. SOLID METAL	a) Soft aluminum	4.00	10 000	
	b) Soft Copper c) Admiralty	4.75	14 000	
	d) Iron e) Soft Steel f) Monel	5.50	18 000	
	g) 4-6% Chrome h) 11-13% Chrome	6.00	21 000	
	j) KA2S k) Type 316	6.50	24 500	

TABLE B
EFFECTIVE GASKET YIELDING WIDTH



FACING SKETCH (exaggerated)	EFFECTIVE GASKET YIELD WIDTH b
1	$\frac{n}{2}$
2	$\frac{n+w}{4}$
3	$\frac{n}{4}$
4	$\frac{n}{3}$
5	
6	$\frac{n}{4}$
7	
8	$\frac{w}{8}$

*NOTE. To simplify application, these factors are adjusted to the assumption that the internal pressure load is effective to the center line of the ring gasket, which adjustment inserts a plus factor of 0.50 (approximately) in the internal pressure load calculation. Consequently the values of m listed above should be used in the gasket load calculations, although without this simplification the actual unit gasket load would be calculated at (m + 0.50) times the internal pressure.

Operating or working conditions:

$$W_m = H + H_p = 0.785\,G^2p + (2\,b \times 3.14\,Gmp) \ldots\ldots [1]^1$$

Atmospheric temperature conditions without internal pressure:

$$W_m = H_y = 3.14bGyr \text{ (See note 2)} \ldots [2]$$

Under the above requirements the minimum required bolt load W_m in pounds will be at least sufficient:

Under maximum operating or working conditions, to resist the hydrostatic end force (H) in pounds exerted by the internal working pressure upon the area bounded by the mean diameter of gasket or joint contact surface, and in addition maintain a predetermined compression load (H_p) on the gasket or joint-contact surface which, experience has shown, will be sufficient to assure a tight joint (See note 1).

Under atmospheric temperature conditions without the presence of internal pressure, to exert a load (H_y) to initially seat the gasket or joint-contact surfaces sufficiently to assure a tight joint (See notes 2 and 3).

(*b*) Actual Bolt Load W_a. The actual bolt load, which shall be at least equal to the minimum required bolt load defined in (*a*) above, is the force in pounds available when the actual total bolt area is stressed to the maximum allowable working stress at the operating temperature (See note 4), and is determined in accordance with formula (3).

$$W_a = A_b \times S_b \ldots\ldots\ldots\ldots [3]$$

(*c*) Flange Design Bolt Load W. The bolt load used in the design of the flange shall be not less than the average of the minimum required bolt load W_m, defined in (*a*) above, formula (1) or (2), and the actual bolt load W_a, defined in (*b*) above, formula (3) or

$$W = \frac{W_m + W_a}{2} \text{ (See note 5)}$$

NOTE 1. Table UA-7 gives a list of many commonly used gasket materials and contact facings, with suggested values of m, b, and y that have been proved satisfactory in actual service. These values are suggestive only and are not mandatory. Values that are too low may result in leakage at the joint, without

[1] See Table UA-7½ for definitions of all symbols.

affecting the safety of the design. The primary proof that the values are adequate is the hydrostatic test.

NOTE 2. The value r is inserted in order to allow direct comparison of the operating temperature loading and initial atmospheric temperature loading and thus makes use of the allowable operating temperature bolt stress only, in the remaining calculations.

NOTE 3. The need for providing sufficient bolt load to seat the gasket or joint-contact surfaces, in accordance with formula (2), will prevail on many low pressure designs and in such cases where facings and materials requiring a high seating load are employed, wherein the bolt load required for the operating conditions, formula (1), is insufficient to initially seat the joint. Similarly, on extremely high pressure designs where the bolt load is usually governed by the operating conditions, it may be necessary to assure sufficient gasket or joint contact area to avoid crushing under the initial tightening of the bolts.

NOTE 4. Ordinarily the bolting is selected to correspond with the minimum requirements of (a) above, with some unavoidable excess resulting from selecting the number of bolts, such as in multiples of four. In other cases, particularly on low pressure designs, excess bolting is provided in order to maintain bolt spacings within reasonable limits to assure more uniform loading.

NOTE 5. This provides, in addition to the minimum requirements for safety, a margin against abuse from overbolting of 50 per cent of the excess above the required minimum. It is necessarily assumed that reasonable care will be taken in tightening the bolts, since any abuse from overpulling the bolts may affect the satisfactory operation of the unit or decrease the margin of safety.

Where additional safety against abuse is desired, or where it is necessary that the flange be suitable to withstand the full available bolt load, the flange may be designed on the basis of the actual bolt load W_a, as defined in (b) above.

UA-21 Flange Moments. The moments acting upon the flange and used in the calculation of the flange stresses shall be determined as follows:

(a) Integral Type Flanges. For flanges integral with the nozzle neck or the vessel, as shown in Fig. UA-2 (a), and flanges attached thereto by welding as shown in Fig. UA-2 (b), (i), (j), (k), and (l), the total moment shall be at least equal to the sum of the moments acting upon the flange, or

Flange loads	× lever arms	= moments
$H_D = 0.785\, B^2 p$	$h_D = R \times \frac{g_1}{2}$	$M_D = H_D \times h_D$
$H_T = H - H_D$	$h_T = R + \frac{g_1 + h_G}{2}$	$M_T = H_T \times h_T$
$H_G = W - H$	$h_G = \frac{C - G}{2}$	$M_G = H_G \times h_G$

and total moment $M_o = M_D + M_T + M_G$

(b) Other Flanges. (1) For loose flanges with or without a hub, and having a gasket only partially covering the face of a lap on the end of the nozzle neck or vessel, as shown in Figs. UA-2 (c) and (e), and flanges screwed or riveted to the nozzle neck or vessel, as shown in Fig. UA-2 (g), and flanges with a hub and lap-welded as shown in Fig. UA-2 (h), the total moment shall be determined as in (a) above, except that the force H_D shall be considered to act at the inside diameter of the flange, in which case:

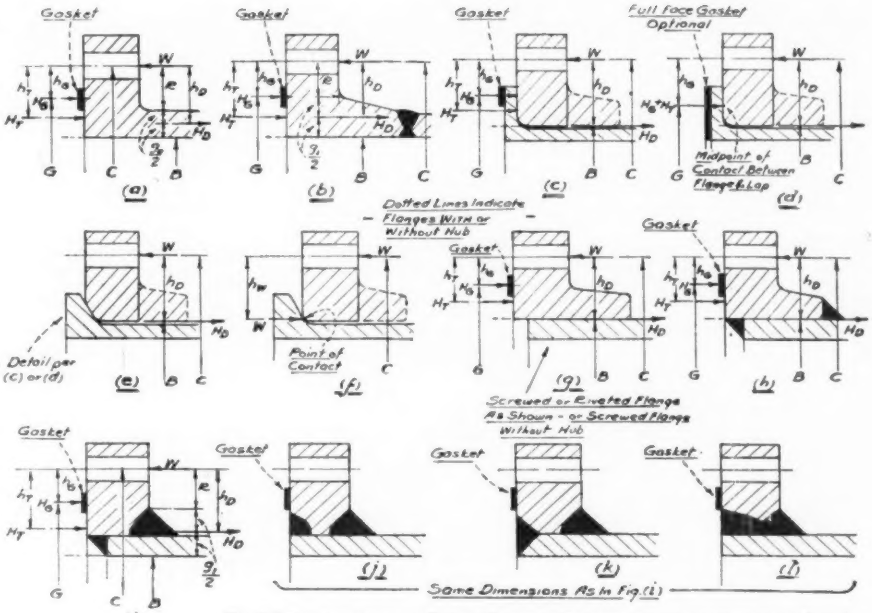
$$h_D = \frac{C - B}{2}$$

$$h_T = \frac{h_D + h_G}{2}$$

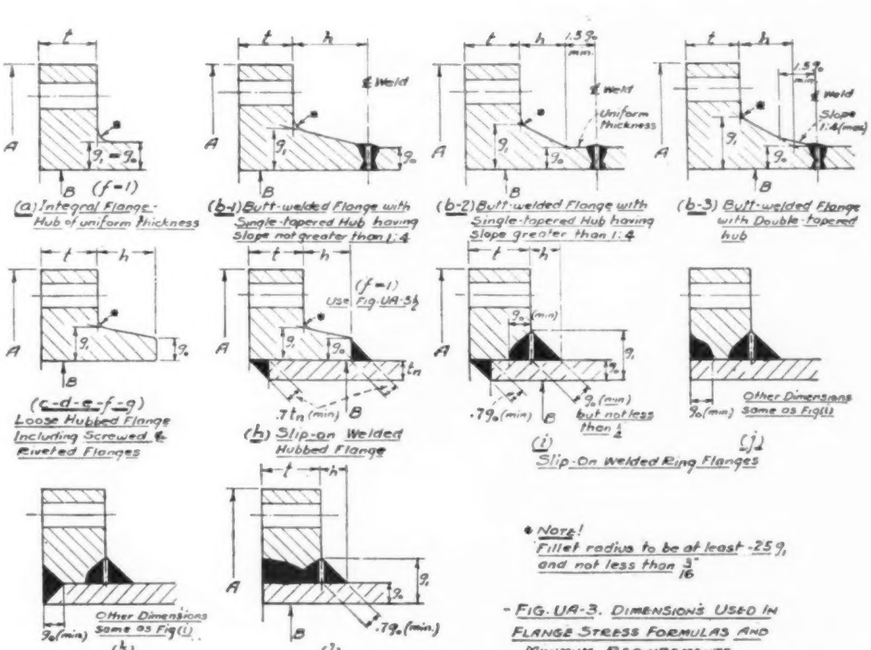
(2) For loose flanges with or without a hub and having contact over the entire face of a lap on the end of the nozzle neck or vessel, with or without a gasket, as shown in Figs. UA-2 (d) and (e), the total moment shall be determined as in (a) above, except that the force H_D shall be considered to act at the inside diameter of the flange, in which case:

$$h_D = \frac{C - B}{2}$$

$$h_G = h_T = \frac{C - G}{2}$$



—FIG. UA-2 SOME TYPES OF BOLTED FLANGED CONNECTIONS – Facing Details Optional.



- FIG. UA-3. DIMENSIONS USED IN FLANGE STRESS FORMULAS AND MINIMUM REQUIREMENTS
(Sketch letters correspond with those of FIG. UA-2)

(3) For loose flanges with or without a hub and having line contact between the flange and a lap on the end of the nozzle neck or vessel as shown in Fig. UA-2(*f*) the total moment shall be at least equal to the product of the design bolt load W and lever arm h_W, or

$$M_o = W \times h_W$$

(*c*) No consideration shall be given to any possible reduction in lever arm due to cupping of the flanges or due to inward shifting of the line of action of the bolts as a result thereof.

UA-22 Flange-Design Stresses. The stresses in the flange as calculated from the formulas in Par. UA-23 shall not exceed the values indicated as follows:

(*a*) For flanges integral with the nozzle neck or vessel and all hubbed flanges either loose or attached,

Longitudinal hub stress S_H not greater than $1.5\,S_{all}$

Radial flange stress S_R not greater than S_{all}

Tangential flange stress S_T not greater than S_{all}

also; $\dfrac{S_H + S_R}{2}$ not greater than S_{all}

$\dfrac{S_H + S_T}{2}$ not greater than S_{all}

For hubbed flanges attached as shown in Figs. UA-2 (*g*) and (*h*) the nozzle neck or vessel shall not be considered to have any value as a hub.

(*b*) For ring flanges welded to the nozzle

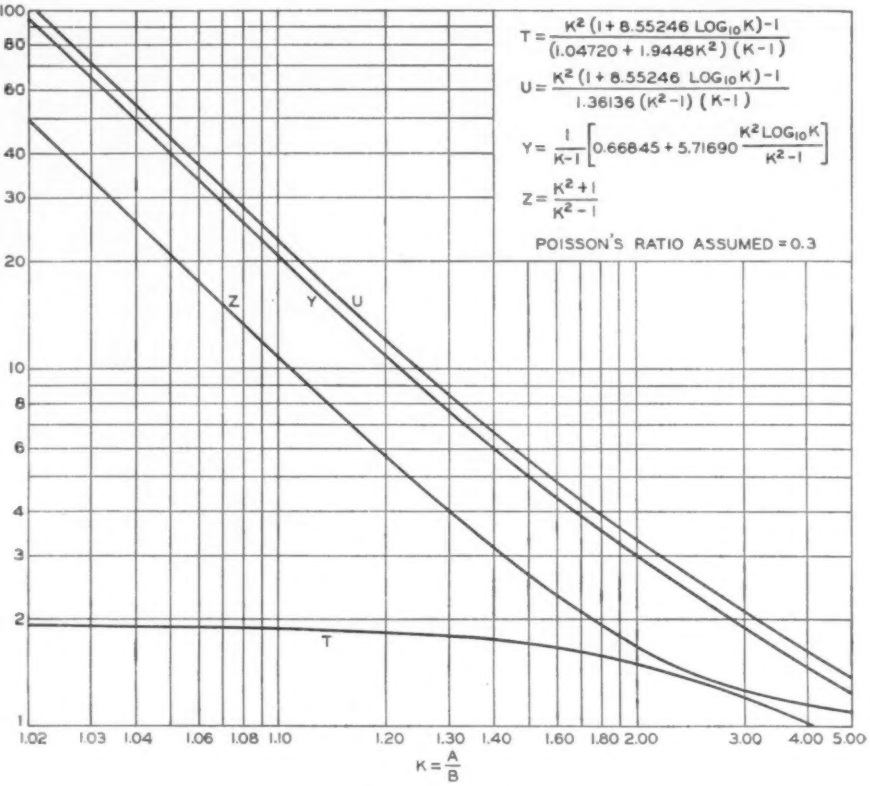


FIG. UA-4 VALUES OF T, U, Y, AND Z (TERMS INVOLVING K)

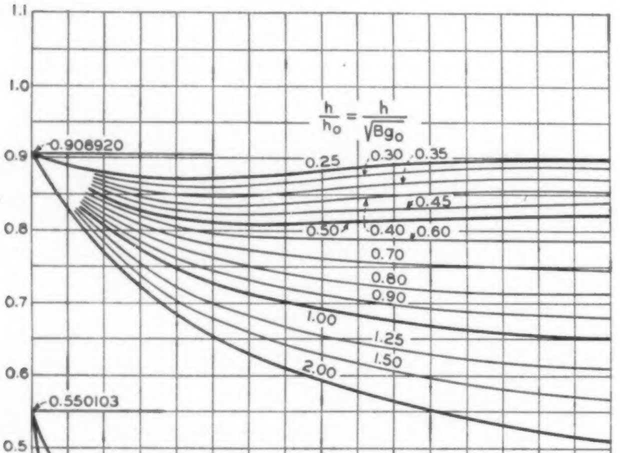


FIG. UA-5 VALUES OF F AND V (INTEGRAL FLANGE FACTORS)

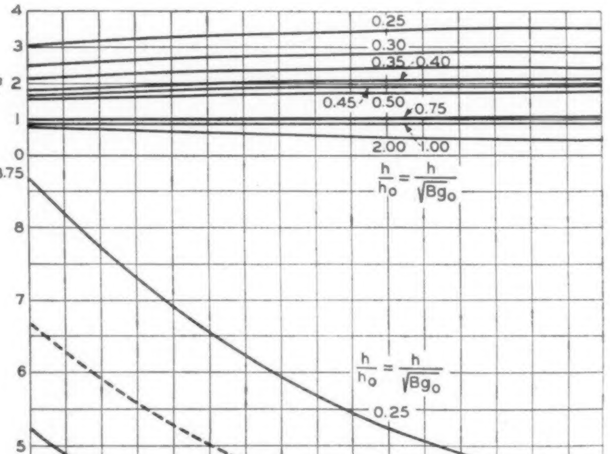


FIG. UA-5½ VALUES OF F_L AND V_L (LOOSE HUB FLANGE FACTORS)

neck or vessel, as shown in Figs. UA-2 (*i*), (*j*), (*k*), and (*l*), the values of S_H, S_R, and S_T shall not exceed the maximum allowable working stress S_{all}, based on the material having the lowest value of S_{all} at the operating temperature. These types of flanges shall be considered as flanges having a tapered hub, with dimensions as shown in Fig. UA-3.

(*c*) For loose ring flanges as shown in Figs. UA-2 (*c*), (*d*), (*e*), (*f*), and (*g*), the stress S_T shall not exceed the maximum allowable working stress S_{all}.

(*d*) For flange rings fabricated by rolling a bar to a circle and butt welding the ends to form a complete ring, the stress S_T shall not exceed the product of the maximum allowable working stress S_{all} and the joint efficiency of the weld as specified in this section of the Code.

(*e*) In addition to the above, all weld dimensions and other details as indicated shall conform to the dimensions as shown in Fig. UA-3.

UA-23. Calculation of Flange Stresses. The stresses in the flange, determined in accordance with the following formulas, shall not exceed the values specified in Par. UA-22.

(*a*) For integral flanges and all hubbed flanges

Longitudinal hub stress $S_H = \dfrac{fM_o}{Lg_1^2 B_1}$

Radial flange stress $S_R = \dfrac{(4/3\ te + 1)M_o}{Lt^2B}$

Tangential flange stress $S_T = \dfrac{YM_o}{t^2B} - ZS_R$

(*b*) For loose ring flanges and ring flanges attached by means not considered as integral construction:

$$S_T = \frac{YM_o}{t^2B} \qquad S_R = o \qquad S_H = o$$

TABLE UA-7½ NOMENCLATURE AND VALUES (See also Figs. UA-2 and UA-3)

W_m = minimum required bolt load, lb, Par. UA-20 (*a*)

W_a = actual or maximum available bolt load, lb, Par. UA-20 (*b*)

W = flange design bolt load, lb, Par. UA-20 (*c*)

H = total hydrostatic end force, lb = 0.785 G^2p, Par. UA-20 (*a*)

H_p = total joint-contact-surface compression load, lb, Par. UA-20 (*a*)

H_y = total joint-contact-seating load, lb, Par. UA-20 (*a*)

G = mean diameter of gasket or joint-contact surface, in., except as noted in Fig. UA-2 (*d*)

p = maximum allowable working pressure, lb per sq in.

*b = effective gasket or joint-contact-surface seating width, in.

*$2b$ = effective gasket or joint-contact-surface pressure width, in.

*m = unit contact compression factor

*y = gasket or joint-contact-surface unit seating load, lb per sq in.

*r = S_b/S_a, or ratio of maximum allowable bolt stress at operating temperature to maximum allowable bolt stress at atmospheric temperature

S_b = maximum allowable bolt stress at operating temperature, lb per sq in. = 1.25 times the values given in Table U-2

$\left.\begin{matrix}F\\V\end{matrix}\right\}$ = factors for integral flanges, obtain from Fig. UA-5

$\left.\begin{matrix}F_L\\V_L\end{matrix}\right\}$ = factors for loose hubbed flanges, obtain from Fig. UA-5½

f = hub stress correction factor (for integral flanges), obtain from Fig. UA-6 using values $\dfrac{g_1}{g_o}$ and $\dfrac{{}^*h}{h_o}$. For values below that shown in Fig. UA-6, use $f = 1$

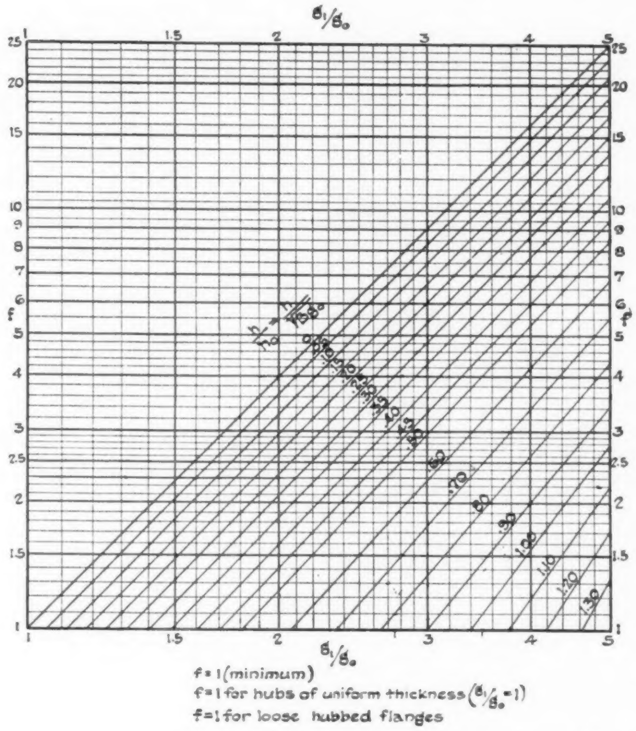


FIG. UA-6 VALUES OF f (HUB STRESS CORRECTION FACTOR)

S_a = maximum allowable bolt stress at atmospheric temperature, lb per sq in. = 1.25 times the values given in Table U-2

A_b = total cross-sectional area of bolts at root of thread or section of least diameter under stress, sq in.

A = outside diameter of flange, in.

B = inside diameter of flange, in.

C = bolt circle diameter, in.

R = radial distance from bolt circle to point of intersection of hub and back of flange, in. (integral and hubbed flanges)

g_1 = thickness of hub at back of flange, in.

g_o = thickness of hub at small end, in.

M_o = total moment acting upon the flange

K = A/B or ratio of outside diameter of flange to inside diameter of flange

$\left.\begin{matrix}T\\U\\Y\\Z\end{matrix}\right\}$ = terms involving factor K, obtain from Fig. UA-4

* See note 1, Par. UA-20.

** See note 2, Par. UA-20.

h = hub length

t = flange thickness, in.

$L = \dfrac{te + 1}{T} + \dfrac{t^3}{d}$

$d = \dfrac{U}{V} h_og_o^2$ for integral flanges

$= \dfrac{U}{V_L} h_og_o^2$ for loose flanges

$e = \dfrac{F}{h_o}$ for integral flanges

$= \dfrac{F_L}{h_o}$ for loose flanges

$B_1 = B + g_1$ for loose hubbed flanges and for integral flanges when $f < 1$ (below chart in Fig. UA-6)

$B_1 = B + g_o$ for integral flanges when $f > 1$

S_{all} = maximum allowable working stress for flange material, lb per sq in. = 1.25 times the values given in Table U-2.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

It's About Time

IT'S ABOUT TIME. By Paul M. Chamberlain. Richard R. Smith, New York, N. Y. Cloth, $6^3/_4 \times 10^1/_4$ in., 490 pp. illus. $7.50.

REVIEWED BY P. R. HOOPES[1]

THIS book is the result of an engineer's hobby. Paul Mellen Chamberlain, a structural engineer who retired from active professional practice after World War I, devoted the last twenty years of his life to collecting watches. He accumulated twelve hundred specimens, studied their construction, made scale drawings of many of them, and familiarized himself with much of the literature of the art. At the time of his death in 1940 he was an internationally recognized authority on the evolution of watch movements and on the history of the industry. His practical skill was such that he was quite equal to taking down, measuring, reassembling, and regulating priceless antique timepieces. His shop was an amateur's paradise.

"It's About Time" is made up of reprints of the technical, descriptive, and historical articles which Chamberlain wrote during the formation of his collection. The text is splendidly illustrated and conveys much of the author's enthusiastic interest in and knowledge of his subject. It is not obvious why this sound and scholarly work should be burdened with such an inept title.

The first half of the book is devoted to escapements, special emphasis being placed upon varieties of the lever escapement. The author assumes throughout that the reader is acquainted with the fundamentals of the design of these mechanisms. His purpose is to illustrate and describe the more interesting escapements found in important watches in his own and other collections, and to review the developments which have taken place since the latter part of the seventeenth century. So much has been written on this subject during the past two hundred years that any new book in the field inevitably involves a measure of repetition. However, the fact that Chamberlain went for most of his material directly to the watches themselves, rather than to books, gives his work a freshness of viewpoint and observation too often absent from the literature of clock- and watchmaking. Occasionally it involves him in difficulties. These are principally due to the collector's natural tendency to overestimate the significance of some of his own specimens. Such questionable expressions of opinion are neither numerous nor important, and do not in the least detract from the technical value of the descriptions.

The chapter on the development of the escapement is a compilation consisting of random notes illustrated with nearly one hundred drawings reproduced from the classic French and English works on clock- and watchmaking. Lacking systematic or chronological arrangement, it nevertheless affords a comprehensive review of a large number of the principles which have been suggested during the past three hundred years for controlling the pendulum and balance wheel. Oddly enough, Galileo's pendulum escapement is omitted, and the reader will look in vain for any indication that either Italian or German watchmakers contributed importantly to the development. A short, well-selected bibliography supplements the discussion.

Biographical sketches of fifty prominent watchmakers of the past three centuries constitute the concluding portion of the book. Brief, informal, and sympathetic, they are extraordinarily successful in projecting the personalities of these men against a background of their technical accomplishments.

This is one of the most satisfactory works yet written on the subject. It is warmly recommended to collectors, to watchmakers, and to students of mechanism.

[1] Consulting Mechanical Engineer, Philadelphia, Pa. Mem. A.S.M.E.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Harrison W. Craver, Director, Engineering Societies Library, 29 West 39th St., New York, N. Y.

Career in Engineering

CAREER IN ENGINEERING. By Lowell O. Stewart, The Iowa State College Press, Ames, Ia., single copies 75 cents.

REVIEWED BY R. L. SACKETT

IN HIS introduction to this 87-page booklet, Professor Stewart, head of the department of civil engineering, Iowa State College, says: "In each instance, I have tried to answer as fairly as possible those questions that arise in all discussions of vocations, as well as others that may be peculiar to engineering. Three of these standard questions are: What does one do? What are the qualifications? What are the prospects for the future in this field?"

If each inquiring high-school student, counselor, and teacher will read the introduction, he will get a sound answer to the third question.

"What Is Engineering?" is the first of six chapters and an appendix. This one gives the historical background, sketches the several technical or engineering societies, and then does a valuable service in defining the distinction between skilled artisans or craftsmen, engineering technicians, and the professional engineer. There is no trace of snobbery or "high hat" but it tries to plant the idea which society was inclined to forget, viz., that engineering, in the large, needs all three. No suggestions of limitation on how far anyone may rise are made.

Registration is given due attention.

"Who Should Study Engineering," chapter 2, is devoted to a discussion of aptitudes, with emphasis on mathematics, space visualization, and manual skill. The ability to use "one's hands with considerable dexterity is a very use-

ful but scarcely essential trait in engineering." The importance of drawing, chemistry, and physics is duly emphasized.

Interest, test for interest, ***interpretation*** of tests, high-school grades, and summer jobs are all discussed. The reviewer italicizes "interpretation" because the main value of such tests is to provide a basis for a common-sense interview in which the results or implications of tests form a fertile subject through which to gain a more complete diagnosis of the boy, his ***present*** interests and their permanency and significance.

Personal qualifications and personality traits receive honorable mention but not as much emphasis as they deserve. In the main, they determine the quality of the prospective professional engineer.

Chapter 3 is called "What the Engineer Does." Each of eight fields of engineering is described and illustrated with from 2.5 to 4 pages each devoted to agricultural, architectural, ceramic, chemical, civil, electrical, general, and mechanical engineering. A question may be raised about general engineering as a field. It is rather a curriculum. Industrial engineering has more of a claim for a place than general engineering on several grounds. Aeronautical engineering also might claim front-page attention.

All the divisions are treated clearly, without prejudice and with equal emphasis.

The functional analysis of engineering occupies chapter 4, "What the Engineer Does." Research, design, development and experiment, construction and manufacturing, sales, commercial application, service, and operation are adequately presented.

Chapter 5 is a continuation of "What the Engineer Does" but discusses the opportunities for careers in various industries in order from automotive to aviation, chemical industry, electrical manufacturing, electrical utility, food technology and manufacturing, petroleum industry, radio, railway, refrigeration and air conditioning, rubber industry, steel industry, telephone industry, and federal, state, and city departments. The spread of subjects is unusually suggestive of the scope of engineering.

The concluding chapter on "Factors Determining Success" deserves its important place as the climax. Conditions in college, earning one's way, and how to study are given proper attention.

"Salary and Security" is not a dialectic on modern political sociology but a discussion of earnings in good times and bad with a table from the Federal Bureau of Labor.

The heart of this chapter, indeed of the booklet, is in "Success After College." What is success? is answered by a quotation from H. G. Wells as follows: "Wealth, notoriety, place, and power are no measure of success whatever. The only true measure of success is the ratio between what we might have done and what we might have been on the one hand and the thing we have done and thing we have made of ourself on the other."

An editorial in MECHANICAL ENGINEERING for September, 1931, is quoted as follows:

> How to acquire this powerful quality that is so important to success wherever human beings are concerned we do not know. If a man is not born with it in his character he quite possibly may never acquire it. If he does not cultivate it he squanders a precious heritage. If he does not realize its absence he is likely to be doomed to a thwarted and disappointed career should he attempt one in fields where such a gift is necessary. All in all it is a fundamental to be thoughtfully considered lest a lame man become soured and find life fruitless and unhappy because he cannot run a race.

Finally, the factors that contribute to success are catalogued—such as character, judgment, efficiency, understanding of men, knowledge of fundamentals and technique—from Dr. Mann's report of 1916 to the Carnegie Foundation.

The paper is of excellent quality and the cuts are not only an ornament but tell a story. The typography is superior and the English is good. The pamphlet is not a treatise and criticisms can be made of the descriptions of the various fields, but within its limitations of size it is commendable.

Books Received in Library

A.S.T.M. STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS, prepared by A.S.T.M. Committee D-2 on Petroleum Products and Lubricants. Methods of Testing, Specifications, Definitions, Charts, and Tables. September, 1941. Paper, 6 × 9 in., 400 pp., American Society for Testing Materials, Philadelphia, Pa., diagrams, charts, tables, $2. This pamphlet brings together in convenient form the 1941 report of the A.S.T.M. committee on petroleum products and lubrication, over ninety standard and tentative methods of test and specifications pertaining to petroleum, and the regulations and personnel of the committee and subcommittees.

AERODYNAMICS OF THE AIRPLANE. (Galcit Aeronautical Series). By C. B. Milliken. John Wiley & Sons, Inc., New York, N. Y., 1941. Cloth, 6 × 9 1/2 in., 171 pp., illus., diagrams, charts, tables, $2.50. This volume presents a brief but rather intensive summary of those portions of the subject which every well-rounded aeronautical engineer should know. Fundamental fluid mechanical principles are first presented, followed by a discussion of certain of them to specific aerodynamic questions. Airplane performance, stability, and control are then treated. The book is based upon lectures to graduate nonaeronautical engineers.

AEROPLANE CARBURETORS (Part 2). Edited by E. Molloy and E. W. Knott. Chemical Publishing Co., New York, N. Y., 1940. Cloth, 6 × 9 in., 132 pp., illus., diagrams, charts, tables, $2. This handbook describes in detail the dismantling, adjustment, and reassembling of aircraft carburetors of the Zenith, Rolls-Royce, and Stromberg types. Chapters on Boost pressure control and mixture strength and on the Cambridge exhaust-gas analyzer are also included.

AIR PILOTING, Manual of Flight Instruction. By V. Simmons. Revised edition, Ronald Press Co., New York, N. Y., 1941. Cloth, 5 × 8 1/2 in., 758 pp., illus., diagrams, charts, tables, $4. The intention of this book is to illustrate and describe the best-known means of developing pilot skill, and in addition to supply technical material, in text and question-and-answer form, which will definitely aid the applicant in passing the various written examinations. The present revision provides the currently approved techniques for the training and testing of pilots.

AIRCRAFT DESIGN SKETCH BOOK, compiled and published by Lockheed Aircraft Corporation, Burbank, Calif. Aero Publishers, Glendale, Calif., 1940. Paper, 8 1/2 × 11 in., paged in eleven sections, illus., diagrams, tables, $3. Some hundreds of sketches of airplane parts and complete aircraft, both military and commercial, compose this book. Brief descriptive information is included in many cases. The purpose of the book is to give the designer a collection of ideas that will stimulate his own creative and inventive mind toward further development.

AIRCRAFT INSTRUMENTS. By G. E. Irvin. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, 6 × 9 1/2 in., 506 pp., illus., diagrams, charts, maps, tables, $5. This book aims to provide, in one volume, a complete course in the subject for all those concerned. The construction and operation of all types are described, and detailed instructions given for installing, using, testing, maintaining, and repairing them.

AIRCRAFT LOFTING. By E. P. Grenier. Published by Emile P. Grenier, Buffalo, N. Y., 1941. Fabrikoid, loose-leaf manifold copy, 202 pp., diagrams, charts, tables, $3. This textbook has been developed as a result of the application of lofting methods to mass production of aircraft. In addition to presenting a practical study of aircraft loft practice, it also includes sufficient information to give an understanding of the necessary mathematical, engineering, and aerodynamical concepts. Full use is made of illustrative diagrams.

AIRCRAFT YEAR BOOK FOR 1941, Twenty-third annual edition, edited by H. Mingos. Aeronautical Chamber of Commerce of America, New York, N. Y., 1941. Cloth, 6 × 9 in., 608 pp., illus., diagrams, maps, tables, $5. This annual records the developments of American aviation during the last year. Both civil and military activities are reported in considerable detail. Training and education, the growth of air lines and private flying, and the increase in airports and airways are described. The expansion of manufacturing is

presented. There are tables of aircraft and engine specifications and much statistical matter.

AIRSCREWS, Part 2. (Aeroplane Maintenance and Operation Series, vol. 20.) Edited by E. Molloy and E. W. Knott. Chemical Publishing Co., New York, N. Y., 1940. Cloth, 6 × 9 in., 100 pp., illus., diagrams, $2. Continuing the airplane maintenance and operation series, this second volume on airscrews deals with the Rotol, Curtiss, Hamilton, and Hele-Shaw Beacham variable-pitch airscrews. A section of general notes on the operation, maintenance, and inspection of fixed-pitch airscrews is included.

BELL TELEPHONE SYSTEM. By A. W. Page. Harper & Brothers, Publishers, New York, N. Y., and London, England, 1941. Cloth, 6 × 9 in., 248 pp., illus., diagrams, charts, maps, tables, $2. This is a description of the operating policies of the American Telephone and Telegraph Company and its constituent companies, written by the vice-president in charge of public relations. Problems of research, technology, wages, rates and service, relations with the government, and finance are considered, and the methods and achievements of the organization set forth. Much hitherto scattered information is brought together in convenient form.

CHEMICAL ENGINEERS' HANDBOOK. (Chemical Engineering Series.) Edited by J. H. Perry. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Leather, 5 × 7 in., 3029 pp., illus., diagrams, charts, tables, $10. The new edition of this valuable reference work has been thoroughly revised and largely rewritten to bring it abreast of current practice. New sections have been added on solvent extraction; on shotting, granulating and flaking, and sprays and spraying; on bulk packaging and on sublimation. Many new chapters have been added. The section on patents and patent law has been omitted, but the new edition nevertheless contains nearly four hundred pages more than the previous one. The work covers the field of chemical engineering comprehensively.

DESIGN OF PIPING SYSTEMS, EXPANSION STRESSES AND REACTIONS IN PIPING SYSTEMS. Published by M. W. Kellogg Company, New York, N. Y., 1941. Cloth, $8^1/_2 \times 11^1/_2$ in., 97 pp., illus., diagrams, charts, tables, $10. The general method of analyzing pipe lines for flexibility presented in this manual is applicable to piping systems of almost any shape or configuration such as are needed in the power, oil-refinery, and chemical industries. The derivation and application of formulas for expansion stresses and reactions are presented in a detailed manner, design data are furnished, and there is a bibliography.

FIRE SERVICE HYDRAULICS. By F. Shepperd. Case-Shepperd-Mann Publishing Corporation, New York, N. Y., 1941. Leather, $5^1/_2 \times 8^1/_2$ in., 254 pp., illus., diagrams, charts, tables, $3. A presentation of the principles of hydraulics as applied to fire-department work. Detailed instructions are given for calculating nozzle velocities and pressures, friction losses in hose and mains, engine pressures, fire streams, sprinkler systems, and pump discharges, and are well illustrated by many worked examples.

Great Britain, Board of Education and Ministry of Labour and National Service. HANDBOOK OF WORKSHOP CALCULATIONS. His Majesty's Stationery Office, London, England. British Library of Information, New York, N. Y., 1941. Paper, 5 × 7 in., 40 pp., diagrams, tables, 3d (obtainable from British Library of Information, New York, N. Y., $0.10). This pamphlet is issued as a guide to students and workers in the engineering industry. The introductory exercise and the practical examples are nearly all solvable by simple arithmetic.

HANDBOOK OF AIRPLANE INSTRUMENTS. Kollsman Instrument Division of Square D Company, Elmhurst, New York, N. Y., 1940. Fabricoid, $9^1/_2 \times 11^1/_2$ in., paged in sections, illus., diagrams, charts, maps, tables, $2. This is a guide to the testing, repairing, and adjustment of airplane instruments, with special attention to those made by the company which issues the book. The directions are full and explicit, and illustrated by many drawings.

HOW TO TRAIN SHOP WORKERS. By C. A. Prosser and P. S. Van Wyck. American Technical Society, Chicago, Ill., 1941. Stiff paper, 8 × 11 in., 126 pp., diagrams, charts, tables, $1.25 manifold copy. This shop-training manual is for the use of foremen and instructors in training workers in production and service jobs. It is intended for both manufacturing plants and vocational schools, and covers the duties, responsibilities, and characteristics of the efficient foreman, as well as practical training methods and suggestions.

MACHINE TOOL OPERATION. Part 1, The Lathe. By H. D. Burghardt. McGraw-Hill Book Co., Inc., New York, N. Y., 1941. Cloth, $5 \times 7^1/_2$ in., 420 pp., illus., diagrams, charts, tables, $2.25. This text for apprentices and young machinists presents the fundamental principles of the construction and operation of all types of lathes, describes benchwork done by hand, and discusses methods of soldering, hardening and tempering, and hand forging. The material added in this revised edition is chiefly on hand forging.

MATERIALS TESTING, Theory, Practice and Significance of Physical Tests on Engineering Materials. By H. J. Gilkey, G. Murphy and E. O. Bergman. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1941. Cloth, $8^1/_2 \times 11^1/_2$ in., 185 pp., illus., diagrams, charts, tables, $2.75. The field of materials-testing work in colleges is covered comprehensively in this laboratory manual, from general observations on test procedures to suggestions upon the conduct of a course of instruction, and on typical final examinations. More material is included than is likely to be used in any one laboratory, in order to provide for wider use. Answers are given for the many supplementary questions, and there is an unusually complete subject index.

MOLDING TECHNIC FOR BAKELITE AND VINYLITE PLASTICS. Bakelite Corporation, New York, N. Y., 1941. Fabricoid, $8^1/_2 \times 11^1/_2$ in., 224 pp., illus., diagrams, charts, tables, $3.50. The important phases of the molding processes and molding equipment employed generally in the commercial production of plastic parts are discussed. Materials, mold design, finishing processes, inspection, and plant layout are among the topics covered. There is a glossary, including a list of terms not recommended.

MOTION STUDY. By H. C. Sampter. Pitman Publishing Co., New York, N. Y., and Chicago, Ill., 1941. Cloth, $5 \times 8^1/_2$ in., 152 pp., illus., diagrams, charts, tables, $1.75. The principles of motion study, as distinct from time study, are presented in a clear and simple manner. Motion symbols are explained, the basic laws and principles of motion economy are discussed, and flow process charts are emphasized in order to eliminate the study of superfluous operations in a series or complete process.

NUCLEAR PHYSICS. (University of Pennsylvania Bicentennial Conference.) By E. Fermi and others. University of Pennsylvania Press, Philadelphia, Pa., 1941. Paper, 6 × 9 in., 68 pp., diagrams, charts, tables, $0.75. This pamphlet contains six papers presented at a conference on nuclear physics held in connection with the bicentenary of the University of Pennsylvania.

PERFORMANCE OF PRESSURE-TYPE OIL BURNERS. (Iowa Engineering Experiment Station Bulletin 151.) Iowa State College, Ames, Iowa, 1941. Paper, 6 × 9 in., 32 pp., illus., diagrams, charts, tables. An investigation of four high-pressure oil burners operated with various nozzles and cycling rates in both conversion and oil-designed boilers is reported in this bulletin. The apparatus and testing procedure are described, and detailed results are given, including the effect of various characteristics upon efficiency.

STRENGTH OF MATERIALS, part 2. Advanced Theory and Problems. By S. Timoshenko. Second edition. D. Van Nostrand Co., Inc., New York, N. Y., 1941. Cloth, 6 × 9 in., 510 pp., illus., diagrams, charts, tables, $4.50. This standard textbook for advanced students, research engineers, and designers has been revised after a period of eleven years. The material, both theoretical and experimental, which has been added, represents recent developments in the fields of stress analysis and experimental investigation of mechanical properties of structural materials. For the most part these additions are applicable to current problems such as airplane construction.

UNITED STATES TENNESSEE VALLEY AUTHORITY. The Pickwick Landing Project, Technical Report No. 3, 1941. Government Printing Office, Washington, D. C. Cloth, $6 \times 9^1/_2$ in., 431 pp., illus., diagrams, charts, maps, tables, $1. The Guntersville Project, Technical Report No. 4, 1941. Tennessee Valley Authority, Treasurer's Office, Knoxville, Tenn. Cloth, $6 \times 9^1/_2$ in., 423 pp., illus., diagrams, charts, maps, tables, $1. Facts about the planning, design and construction of the Pickwick Landing and Guntersville projects on the Tennessee River are presented in these two technical reports. The general program of the Tennessee River system is considered in each case, and the descriptions of the particular projects cover all phases from the preliminary investigations to complete statistical summaries of equipment and costs. Bibliographies are included.

DAS ZAHNRAD, Entwicklung und gegenwärtiger Stand; Beiträge von G. Berndt, E. Heidebroek, H. Hofer, K. Kutzbach, C. Matschoss, O. Kienzle, E. von Soden and A. Thum. V.D.I. Verlag, Berlin, Germany, 1940. Cloth, 7 × 10 in., 132 pp., illus., diagrams, charts, tables, 13.50 rm. In celebration of its twenty-fifth anniversary, the Zahnradfabrik Friedrichshafen A.G. had planned to issue a history of the development and present position of gearing manufacture. Owing to the war, postponement has been necessary, but the two papers already written have been published in this volume. In the first, Dr. Conrad Matschoss traces the development of the gear wheel from ancient times to the present, with the help of many illustrations of historic interest, and provides a bibliography. In the second paper, Dr. Karl Kutzbach discusses briefly the development of tooth shapes.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Accomplishments of D. S. Jacobus and Development of A.S.M.E. Boiler Code Committee Noted at Dinner

WITH the report of the 1941 A.S.M.E. Annual Meeting (MECHANICAL ENGINEERING, January, 1942, pp. 51–71) there was included an account of a testimonial dinner, Dec. 1, 1941, to Dr. D. S. Jacobus, past-president and honorary member A.S.M.E., who retired recently as chairman of the A.S.M.E. Boiler Code Committee.

At this dinner three prepared addresses by A. M. Greene, Jr., Dr. Jacobus, and E. R. Fish, who succeeds Dr. Jacobus as chairman of the Committee, dealt not only with the guest of honor but also with the history and work of the Boiler Code Committee. So infrequently does the Committee "get into the news" except through its routine transactions that the addresses are published in what follows for the purpose of calling attention to its important work.—Editor.

A. M. Greene, Jr., Offers a Resolution

Mr. Toastmaster, Dr. Jacobus, members of the Council, and fellow members of the Boiler Code Committee:

I joined The American Society of Mechanical Engineers in 1895 and among the members of the Society who attracted the attention of the young members were those whom I shall mention, as they may not be known to the younger men here except through textbooks. They were: Frank Ball, George Barrus, J. E. Denton, Charles Emery, John Fritz, W. F. M. Goss, Gus Henning, Fred Hutton, William Kent, Gaetano Lanza, Wilfred Lewis, Captain Manning, Fred Miller, Cecil Peabody, George Rockwood, Oberlin Smith, Henry Supplee, John Sweet, Fred Taylor, Robert Thurston, Henry R. Towne, De Volson Wood, and C. J. H. Woodbury.

These men and their writings were our guides and inspirations.

I have looked over the index of the first twenty volumes of the Transactions of the Society and the longest list of papers and discussions for those papers, excepting those of the early members, Emery, Kent, Oberlin Smith, and Thurston, is that by D. S. Jacobus, an instructor at Stevens Institute of Technology until 1897, who joined the Society in 1889.

I first knew of Dr. Jacobus in my early teaching days through his masterly complete paper published in 1890, one year after joining the Society, "The General Solution of the Transmission of Force in a Steam Engine as Influenced by the Action of Friction, Acceleration, and Gravity." This, by a young instructor in the first year of his membership and seven years before he became professor of experimental mechanics and engineering physics, was but an indication of what was to follow.

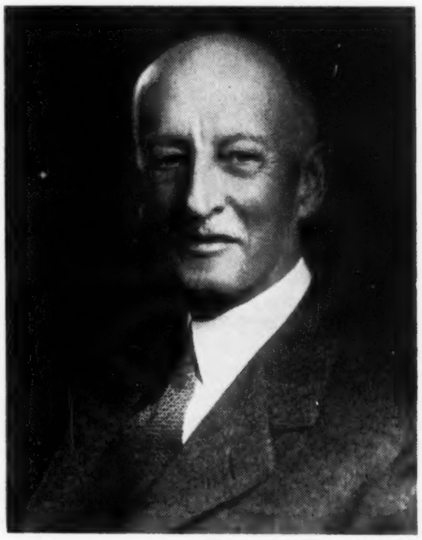
Other papers such as those on accuracy in the use of instruments, on the distribution of moisture in steam when flowing through a horizontal pipe, and on the effect of moisture on steam-engine performance are given in the other volumes of the Transactions during this decade.

His papers since 1906 when he became the advisory engineer of the Babcock and Wilcox Company dealt with power-plant performances and are known to all of you. It was only natural when the Boiler Code was first brought before the Council of the Society in its final form on Feb. 13, 1915, that his name appears as a member of the Advisory Committee representing the builders of the water-tube boiler. I show you the first and third printings of the proposed code with its unnecessary portion and the final report as made in 1915. I read the name of the Committee of that date and the list of various activities represented on the Advisory Committee. Shortly after that date the members of the Advisory Committee were appointed to the Boiler Code Committee and the Code of 1918 bears the names of all those who were living, with the addition of E. R. Fish and F. R. Low.

From the early work of the Advisory Committee and from 26 years of membership on the Boiler Code Committee as well as from his work as President of the Society in 1916, while I was a member of the Council, I have learned to admire Dr. Jacobus for this clarity of thought, for his fairness, for his insistence on exactness and his ability to guide Committee or Council in times of important decisions. To him, more than to any other member, we owe the harmonious action that has marked more than a quarter century of work in the interest of the safety of the public by educators, by boiler designers, by boiler builders, by boiler inspectors, by boiler operators, and by boiler users.

To him the Committee owes much and in closing, Mr. Chairman, I move that we adopt and sign the following statement:

The Boiler Code Committee of The American Society of Mechanical Engineers at its testimonial dinner to Dr. David Schenck Jacobus on Monday, Dec. 1, 1941, wishes to express to him its deep appreciation of all that he has done for the Committee, for the Society, and for the profession of engineering of the world, during his long association with them. They also wish to express their affection for him and admiration for his high character and outstanding tact in handling serious personal and scientific problems. [A facsimile of the signatures to this statement appears on the next page.—EDITOR.]



D. S. JACOBUS

D. S. Jacobus Responds

This is a happy occasion for me even though it is tinged with sadness, said Dr. Jacobus in response. The present strength and importance of the Committee stand out in bold contrast to its position in the days when it was fighting for its very existence. Some of the men now on the Committee have worked together for over 27 years and my own connection with the Code goes back further than this. It is indeed a satisfaction to note the success of our efforts.

The following features bearing on the work of the Committee may be of interest to the Council of the Society:

The Committee is exceptional in that its findings, after being approved by the Council, become law or are used in the interpretation of the law. This has been accomplished through co-operating with representatives of the states and cities that have adopted its Code who serve as a Conference Committee. The two groups have worked in complete harmony and herein lies the secret of the success of the Committee as a lawmaking body.

The Committee has co-operated with all interested parties. It publishes interpretations and proposed revisions in MECHANICAL ENGINEERING and requests criticisms or suggestions. There are now 23 members of the Main Committee, and 141 members of its Conference

Committee, subcommittees, and special committees. All have volunteered their services and have received no financial aid from the Society.

The importance of exercising care and preventing too hasty actions in lawmaking work of this sort was appreciated from the start and a formal objection from a single member of the Committee to an action taken at a meeting has served to reopen and, in some cases, to bring it up again for discussion at a succeeding meeting. It might seem that in a body as large as the Boiler Code Committee this would lead to undue delays. However, the Committee has worked in such good accord that there has been but a single case of a protracted delay which was in formulating rules for allowable working pressures in boiler tubes, but this delay was justified as it led to a more logical solution than any of those first proposed. There has been a spirit of trust and friendship that has made this painstaking practice of unanimous action possible and I earnestly hope that it may be continued. This cordial relationship made it hard for me to resign as chairman but I believed it no more than fair to do so when it became impossible for me to participate in the work as actively as I had done in the past.

There is no better reward than that which comes through the endorsement and confidence of one's friends and there will be no more cherished memories than the hours spent with my loyal co-workers. I wish the new chairman every success and hope he will have as much pleasure as I did in conducting the work.

E. R. Fish Reviews Work of Committee

I know I may say that, without exception, every member of the Boiler Code Committee very greatly regrets that Dr. Jacobus feels that he should resign the chairmanship of the Committee but, at the same time, all are very grateful that he does not feel it necessary to sever entirely his connection with the Committee and will continue as an active member. He is justly entitled to all the recognition and homage that has been extended to him. We have chosen to designate him officially as honorary chairman.

Dr. Jacobus has told you something about the functions of the Boiler Code Committee, but it seems to me well to add to what he has said by giving a brief historical résumé of the beginnings of the Code Committee and also of its relations to certain other bodies.

My connection with the Code Committee extends over a period of 23 active years so that I am fully cognizant of the methods and background of the Committee and of the responsibilities that accompany the chairmanship.

In 1911, Col. E. D. Meier, then President of the Society, recommended to the Council that a committee be appointed "to formulate standard specifications for the construction of steam boilers and other pressure vessels and for their care in service," which committee has since come to be known briefly as "the Boiler Code Committee." A committee of 7 was appointed on Sept. 15, 1911, and a little later an advisory committee of 18 was appointed. It was Colonel Meier's idea that if there was some generally accepted basis for the design of the pressure parts of boilers and pressure vessels, which could be considered as the minimum requirements, a great step woud have been taken to assure safe construction.

In presenting its first report to the Council, several years later, the Committee said: "The primary object of these rules is to secure safe boilers. The interest of boiler users and manufacturers has been carefully considered and the requirements made such that they will not entail undue hardships by departing too widely from present practice. Your committee recommends that you appoint a permanent committee to make such revisions, as may be found desirable, in these rules and to modify them as the state of the art advances and that such committee should hold meetings at least once in two years at which all interested parties may be heard."

But changes in the industry came so rapidly that it was soon found that the plan of having formal hearings at stated intervals for the purpose of considering revisions was quite impracticable. Instead it has become the practice to make annually such revisions as are needed, these being based on the actions taken during the year.

Only Five Remain of Original Committee

The original committee was made a permanent one and in addition the advisory committee of 18 which represented various phases of the design, installation, and operation of boilers was incorporated in the main committee. Of the original 25 men there are now only 5 that remain as active members of the Committee—Dr. Jacobus, Dr. Greene, Mr. Gorton, Mr. Moultrop, and Mr. Obert.

In addition, as mentioned by Dr. Jacobus, the chief inspectors of the states and cities that have adopted the Code as their standard of construction now constitute a Conference Committee with which the Boiler Code Committee is in close contact.

At the beginning of the Code Committee's activities it became apparent that secretarial assistance was essential and provision for this has been continuously afforded by the Society's staff. For the first few years the Committee's office work was carried on with Mr. Obert as secretary. During the depression which followed the first World War Mr. Obert was made honorary secretary with no pay from the Society; and Miss Jurist, who had been his assistant, was made acting secretary. These two have preserved a remarkable record for accuracy in handling over fifty per cent of the correspondence and many telephone and office calls without bringing the matters before the Committee. But in spite of efforts to minimize the work the demands on the Committee have continued to grow until dire necessity forced the employment of a secretary, J. W. Shields, who is just now taking up his duties.

First Edition of Code in 1915

The first edition of the Code was submitted to the Council for its approval on Feb. 13, 1915, nearly 27 years ago. As soon as it appeared, inquiries began coming into the Society headquarters asking what this, that, or the other paragraph meant, so that it became necessary for the Committee to hold regular meetings. These meetings soon became

The Boiler Code Committee of The American Society of Mechanical Engineers at its testimonial dinner to Dr. David Schenck Jacobus on Monday, December 1st, 1941, wishes to express to him its deep appreciation of all that he has done for the Committee, for the Society and for the profession of Engineering of the world during his long association with it. They also wish to express their affection for him and admiration for his high character and outstanding tact in handling serious personal and scientific problems.

monthly affairs, to formulate replies, and such meetings have continued ever since, although the matters that are now discussed are not so much concerned with the meaning of the Code provisions as with the use of new materials, new methods, and new designs for which it is desired to have Code recognition.

The Construction Code covering Power Boilers, i.e., those carrying pressures above 15 psi, was the first one but there have been brought out from time to time Codes covering Low-Pressure Heating Boilers, that is, those carrying pressures below 15 psi, Unfired Pressure Vessels, Boilers of Locomotives, Miniature Boilers, Suggested Rules for the Care of Power Boilers, Rules for Inspection, and Material Specifications. At the very outset a special symbol was devised for boilers and as the other Codes were promulgated similar symbols were provided for each of them in order to indicate the Code under which they were constructed. All of these symbols have the conventional four-leaf clover for the outside boundary within which is enclosed the letter S, U, H, or M to indicate that the boiler, unfired pressure vessel, heating boiler, or miniature boiler complies with Code requirements. Authority to use the Code symbol, a steel die which is supplied from the Boiler Code office, is given only after a written affidavit by the manufacturer that the symbol will be applied only on vessels that comply with all Code requirements. Its presence on a vessel, coupled with other identifying marks, is a guarantee that the vessel is properly constructed.

The older men who have had anything to do with boilers or pressure vessels will recall the great variety of specifications, in which each man incorporated his own ideas, that were once written by consulting engineers and others, going into more or less detail with respect to material, workmanship, etc., so that there was no uniformity of practice. But in the majority of cases there were no such specifications, the boiler manufacturer being depended upon to choose the material and do the detail designing. Naturally, competition contributed to make them cut corners in order to underbid the other fellow with the result that much inferior work was foisted on the purchasers.

It was not long after the several Codes made their appearances that they were generally accepted as the standards of construction so that manufacturers generally began to follow the Code and purchasers have come to merely specify that boilers or other pressure vessels should be built strictly in accordance with the appropriate A.S.M.E. Code.

While two or three states had, prior to 1915, set up some construction rules of their own and required boilers coming into their jurisdictions to be constructed in accordance with their rules, the field elsewhere was legally wide open to any kind of construction.

The A.S.M.E. Boiler Code Committee's Codes have, as Dr. Jacobus has told you, no legal status of themselves.

Not until they have been formally adopted by legislative action of some sort do they have any legal standing. Nor is it a function of the Society to influence legislative action.

It was very quickly understood by those interested in the advantages of uniformity that, in order to have country-wide unanimity, some effort should be made to have those states that already had laws adopt the A.S.M.E. Codes and to persuade those states that had no legal construction or inspection requirements to enact the necessary legislation to provide for the public safety.

To this end the American Uniform Boiler Law Society was organized in 1915 and has been responsible for the enactment of much legislation in many states. Not only that, but it has also been exceedingly useful in preventing the enactment of legislation that would be inimical to uniformity.

Legal Standard in Many States

Not only have states adopted the A.S.M.E. Code but many cities of their own volition have done so. At present 23 states, the District of Columbia, and 34 cities have made the Boiler Construction Code, and in many cases one or more of the other codes, their legal standards.

In addition the Code is recognized as an acceptable standard of construction by many of the government departments, in all the dependencies of the United States, and by many foreign governments.

Reference has been made to the Conference Committee made up of the chief inspectors of those jurisdictions that have accepted the Codes as their standard of construction. The chief inspectors are organized into the National Board of Boiler and Pressure Vessel Inspectors. The function of this organization is not to promote legislation generally but to maintain as nearly as is possible, uniformity in the administration of the Codes and in the decisions that have to be made by the several departments. The Code Committee frequently refers matters to the National Board.

I want to take occasion to say that I think, without exception, the members of the Boiler Code Committee take their responsibilities seriously and recognize the importance of fairness and good judgment as respects all their actions.

While the Code Committee cannot undertake to foresee and provide for future developments, it does make a strong effort to keep abreast of progress. An outstanding example is the recognition of welding as a method of fabrication of pressure vessels of all sorts, in place of riveting. As soon as the Codes provided for welded construction that method was very generally adopted, but that action by the Committee was not taken until it had been amply and incontrovertibly demonstrated that welding could, under proper restrictions, be made safe.

It is doubtful if any other activity of the A.S.M.E. has had more general widespread acceptance and use than the several codes of the Boiler Code Committee, which is now looked to as a court of last resort in matters within its jurisdiction.

Everyone, whether he realizes it or not, and most do not, is interested in the efforts of the Code Committee, for there are innumerable pressure vessels of many kinds all around us. Most of them are out of sight, but none the less are potential hazards. Through these safety construction codes The American Society of Mechanical Engineers has rendered a real service to the country.

A.S.M.E. Spring Meeting

Houston, Texas, March 23–25

National Defense problems will predominate in the program of the Spring Meeting of The American Society of Mechanical Engineers. The Southwest is playing a prominent part in preparing for victory and all members will profit by planning to be present. Sessions include: Petroleum, Power, Fuels, Heat Transfer, Process Industries, and Management. Details will appear in the March issue. Watch for them.

A.S.A. Issues Cadmium Concentration Standard

THE American Standards Association has just announced publication of a standard for Allowable Concentration of Cadmium.

Because of the increasing importance of toxic materials such as cadmium in connection with the defense program and greater hazards to workers due to increased production under emergency conditions, the Association has been requested by health authorities to place several toxic materials needed in defense work on its emergency list of projects. This is the first standard of this group to be completed under this emergency procedure.

Cadmium is used as a substitute for tin in antifriction metals and solders and in bearing metal. It is widely used in cadmium-plating of wire, tools, and other iron and steel articles. It is toxic when absorbed either through the lungs or the gastrointestinal tract and in some cases causes generalized pneumonia. Some of the occupations in which workers are exposed to cadmium hazards include cadmium-alloy making, cadmium plating, colormaking, electroplating, lead smelting, paintmaking, soldering, storage-battery making, textile printing, welding, and zinc smelting.

The new American Defense Emergency Standard describes the properties of cadmium, states the permissible concentration as 1 mg of cadmium per 10 cu m of air, and outlines the sampling procedure and analytical methods to be followed in determining the concentration.

Copies are now available from the American Standards Association, 29 West 39th Street, New York, N. Y., at 20 cents each.

COLLIER AVIATION TROPHY AWARDED FOR DEVELOPMENT OF TURBOSUPERCHARGER

(Vice-President Wallace is shown as he presented the 1940 Collier Aviation Trophy jointly to Dr. Sanford A. Moss, Fellow A.S.M.E., and the Army Air Corps for "outstanding success in high-altitude flying by the development of the turbosupercharger." Major General Walter R. Weaver, acting chief of the Air Corps, right, represented the Air Corps at the ceremony in the Capitol. The trophy, shown at left, is awarded annually by the National Aeronautic Association "for the greatest achievement in aviation, the value of which has been demonstrated by actual use during the preceding year." First presented by the late Robert J. Collier in 1911, it is the oldest and most widely known aviation trophy.)

Edison Medal Awarded to John Boswell Whitehead

THE Edison Medal for 1941 has been awarded by the American Institute of Electrical Engineers to Dr. John Boswell Whitehead, "for his contributions to the field of electrical engineering, his pioneering and development in the field of dielectric research, and his achievements in the advancement of engineering education."

The Edison Medal was founded by associates and friends of Thomas A. Edison, and is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts" by a committee consisting of twenty-four members of the American Institute of Electrical Engineers.

The medal will be presented to Dr. Whitehead during the Winter Convention of the American Institute of Electrical Engineers to be held in the Engineering Societies Building, New York, N. Y.

Bessemer Medal Awarded Eugene G. Grace

E. G. GRACE, President of Bethlehem Steel Company, has been awarded the Bessemer Gold Medal for 1942 by the British Iron and Steel Institute in recognition of his achievements in "fostering collaboration between the steel industries of two leading nations in a great world crisis," according to an announcement by the British Press Service, New York, N. Y.

Founded in 1874, in honor of Sir Henry Bessemer, the Bessemer Gold Medal has become the most highly prized international award for achievement in the steel industry. In its 45 years, the medal has been awarded previously to only three other Americans—Andrew Carnegie, honorary member A.S.M.E., Charles M. Schwab, honorary member and past-president A.S.M.E., and Albert Sauveur.

Brown Will Continue Advanced Courses in Mechanics

DURING the second semester of the current year Brown University will continue the Program of Advanced Instruction and Research in Mechanics which was inaugurated last summer and which has been carried on during the first semester. The courses to be given are: Numerical and graphical methods in applied mathematics; partial differential equations; plasticity; fluid dynamics; and theory of structures. In addition there will be seminars in which research on aeronautics will be carried forward. The staff includes Professors Willy Prager, J. D. Tamarkin, Willy Feller, and Stefan Bergman. Thirty-five men have enrolled for the second semester; there are still one or two small fellowship stipends available for qualified students.

1942 A.S.M.E. Membership List to Be Mailed to All Members in February

THE 1942 A.S.M.E. Membership List, which is Section Two of the February Transactions, will be mailed to all members of The American Society of Mechanical Engineers entitled to receive publications. Those who regularly receive Transactions will find the Membership List in the same envelope with Section One, and others will receive it as a special mailing from the New York office.

Only one copy of the Membership List will be furnished members without charge. If a member fails to receive a copy he should report it prior to April 20 in order to obtain a free copy. The charge for copies furnished after that date, or for extra copies, will be ($1.50) each. It will not be sold to nonmembers of the Society.

Copies of the Membership List will be found in the regular depositories for the Transactions, including the Student Branch libraries. Complimentary copies are also distributed to societies engaged in joint activities with the A.S.M.E. and to other societies which exchange such publications, as well as to certain other organizations approved by the Publications Committee.

Members of the Society are urged to observe the restrictions given on the inside back cover of the Membership List, as follows:

> "The Membership List is issued for the personal use of members of The American Society of Mechanical Engineers in connection with Society and professional affairs. Each member is expected to conserve it and not to permit his copy to be used for the basis of circularization. Such use is annoying to fellow members."

A.S.M.E. Calendar

of Coming Meetings

March 23–25, 1942
Spring Meeting
Houston, Texas

June 8–11, 1942
Semi-Annual Meeting
Cleveland, Ohio

June 17–19, 1942
Oil and Gas Power Division
Peoria, Ill.

October 12–14, 1942
Fall Meeting
Rochester, N. Y.

Nov. 30–Dec. 4, 1942
Annual Meeting
New York, N. Y.

(*For coming meetings of other organizations see page 32 of the advertising section of this issue*)

A.S.M.E. Nominating Committee Urges Members to Suggest Nominees for Office in 1943

Preferably Not Later Than April 1, 1942

The 1942 Nominating Committee urges the members of the A.S.M.E. to give serious consideration to the selection of nominees for elective offices in 1943 and to submit their suggestions promptly, preferably not later than April, 1942.

The offices to be filled are President, three Vice-Presidents to serve two years, one Vice-President to serve one year to fill the vacancy caused by the death of William H. Winterrowd, and three Managers to serve three years. The Constitution, By-Laws, and Rules of the Society, Articles C7, B7, and R7 govern the election of directors.

Forms Will Be Furnished by the Nominating Committee

It is not the duty of the Nominating Committee to solicit nominations, hence no communications will be sent out to Local Sections by the Nominating Committee. The procedure for suggesting nominees to the Committee is to write to the Secretary of the Nominating Committee to obtain the proper forms.

At its organization meeting in December, the Nominating Committee agreed to furnish forms for the convenience of those wishing to suggest nominees. This form contains spaces for most of the information which is essential to full consideration of each proposed nominee. Because the Nominating Committee operates with only meager funds it is requested that eight copies of the form be turned in to the sectional representative on the Committee who will in turn see that each member of the Committee is properly informed. It is unnecessary to have additional forms for endorsers, but the Committee will welcome eight copies of a letter of endorsement from those wishing to support any suggested nominee.

This form when properly filled out presents a list of the activities of the proposed nominee within the Society as well as in other professional and nonprofessional organizations. The candidate's sponsor should also obtain preliminary assurance of willingness and freedom to serve if elected. National professional prominence and leadership are essential to able leadership of the Society. Knowledge of Society affairs and management obtained by previous service on committees is important in enabling the successful candidate to render service to the best of his real ability. The nominees for president and vice-presidents must be of the member or fellow grade; managers may be of any grade of membership.

Those who require additional information to complete the filling out of the nominating form are invited to write to Ernest Hartford, assistant secretary, A.S.M.E., 29 West 39th St., New York, N. Y.

H. W. Smith Elected Chairman

At the organization meeting of the 1942 Nominating Committee on December 4, 1941, H. W. Smith was elected chairman and T. E. Bell was elected secretary. The names of all of the members of the Nominating Committee, the Group they represent, and their addresses are given on this page.

The Committee decided to hold its final executive session during the Semi-Annual Meeting of the Society, June 8–11, 1942 at Cleveland, Ohio. On Tuesday, June 9, of that week an open meeting will be held at which time it is hoped that any member of the Society who desires to appear personally before the Committee, to express his views or to discuss any matters pertaining to nominations, will do so. The hours of the Committee's open meeting will be from 10:00 a.m. to 4:00 p.m. on Tuesday, June 9, at the Cleveland headquarters.

Members' Desires Should Be Learned

It is highly desirable that representative regional groups make every effort to learn the desires of the membership in their region and convey those desires by mail or in person to the Committee through the regional representative.

The necessity of furnishing the Committee with 8 copies of the full and complete record of the proposed nominee before April 1 cannot be overemphasized.

The 1942 A.S.M.E. Nominating Committee

Group	Representative	Alternate
I	E. S. Dennison, Electric Boat Company, Groton, Conn.	J. E. Lovely (1st) Jones & Lamson Machine Co., Springfield, Vt. M. D. Engle (2nd) Boston Edison Co., 182 Tremont St., Boston, Mass.
II	W. McC. McKee, The M. W. Kellogg Co., 225 Broadway, New York, N. Y.	
III	F. C. Stewart, Pennsylvania State College, State College, Pa.	F. A. Allner, Safe Harbor Water Corp., Baltimore, Md.
IV	T. E. Bell, Secretary, Republic Flow Meters Co., 619 Red Rock Bldg., Atlanta, Ga.	James Ellis (1st) Tenn. Eastman Corp., Kingsport, Tenn. A. M. Ormond (2nd) Savannah Sugar Refining Corp., Savannah, Ga.
V	H. W. Smith, Chairman, P. O. Box 349, Ellwood City, Pa.	Max W. Benjamin (1st) 621 S. Denwood Drive, Dearborn, Mich. M. R. Bowerman (2nd) Homeworth, Ohio
VI	O. F. Campbell, Sinclair Refining Co., East Chicago, Ind.	L. H. Stark (1st) Phoenix Knitting Co., Milwaukee, Wis. C. A. Jacobson (2nd) Fairbanks, Morse & Co., Beloit, Wis. M. P. Cleghorn (3rd) Iowa State College, Ames, Iowa
VII	Julius Billeter, 368 G St., Salt Lake City, Utah	W. J. Cope, University of Utah, Salt Lake City, Utah
VIII	E. C. Baker, Okla. A. & M. College, Stillwater, Okla.	A. L. Hill (1st) National Fuse & Powder Co., 3801 Delgany St., Denver, Colo. C. E. Brown (2nd) Burns & McDonnell Engg. Co., 107 W. Linwood, Kansas City, Mo.

Army-Tank Production Described at the Berwick Meeting of Anthracite-Lehigh Valley Section on November 28

WITH a large attendance of members and guests, the Anthracite-Lehigh Valley Section of The American Society of Mechanical Engineers held its meeting of Nov. 28 in Berwick, Pa., the home of The American Car and Foundry Company, one of the largest producers of tanks for the United States Army. Following the dinner, Frederick A. Stevenson, senior vice-president of the company, addressed the engineers on the subject "Army Tanks" and told the story of a company manufacturing railroad cars turning to a new type of production in the defense field; starting from scratch to successfully develop not only the making of tanks but the providing of armor plate for them to such an extent that today the company is also supplying armor plate to other companies.

Mr. Stevenson revealed that his company is producing about twenty tanks a day and that from reports of these tanks in action it can be said that American-designed and built tanks surpass anything yet produced anywhere else, size for size. In the actual design and construction of the M-3 tank, there were 3254 different drawings involved, and the number of blueprints required for initial distribution totaled 48,810. As developments justified the revision and improvements in design, 3529 drawings had to be changed. In a tank there are 3263 different designs of parts, exclusive of the engine and accessories, and there are 14,980 pieces of these various parts in one tank.

The tank itself, Mr. Stevenson stated, weighs approximately 13 tons, of which one third is armor plate. It carries a crew of four men, and is well provided with fighting materials and a two-way radio. It is propelled by a rotary-type engine and is capable of very high sustained speeds for a vehicle of its size and weight. It is very much of a precision job—and materials and tolerance are of the best and closest practical for the purpose.

Furthermore, the participation of the company is not limited to the production of tanks alone. At various other plants of the company, there are being produced shells and shell forgings of various sizes, demolition bombs, mine-sweepers, tank barges, fuses, etc. The meeting was concluded with the showing of slides and motion pictures, which helped those present visualize some of the points brought out in the paper, and with a general discussion and question period.

Atlanta Section Learns About Modern Steam-Power Plants

THE Nov. 17 meeting of the Atlanta Section held jointly with the Georgia Tech Student Branch heard J. A. McLennan, mechanical engineer of Commonwealth and Southern Corporation, outline many interesting and little-known facts about modern steam-power-plant design.

F. V. Murphy Addresses Baltimore Section

Frederick Vernon Murphy, speaker at the Nov. 24 meeting of the Baltimore Section, opened up a new field for thought in his speech on the need for future co-operation between the architect and the engineer in industry. After discussing his early career as an architect and his associations with various engineers, he discussed future architectural trends and the importance of the engineer in their development.

Birmingham Section Discusses Defense Spending and Victory

More than 180 members and guests of the Birmingham Section at the Oct. 27 meeting listened in amazement as Captain A. A. Nichoson, The Texas Company, discussed the huge sums expended in defense work. Yet, not until the final peace will we learn the exact sums spent, he stated. Only by applying our vast resources and taxing American ingenuity to its utmost can we bring about final victory over our enemies and live thereafter prosperously in a victorious democracy, Captain Nichoson concluded.

Production Methods, Motion Studies at Bridgeport

To a highly interested audience of 60 members and guests present at the Dec. 17 meeting of the Bridgeport Section, Prof. Carlos De Zafra, New York University, spoke about the "Tremendous Trifles" of motion studies, inspection methods, and use of proper tools and gages in present-day industry. Such trifles as the foregoing coupled with employee co-operation can do much to gear industry to top speed, now a dire need in this present economic crisis, he stated.

Buffalo Holds Joint Meeting With S.A.E. on Die-Casting

A joint meeting of the Buffalo Section was held Dec. 16 with the local chapter of the S.A.E. They had as their speaker Joseph Fox, who spoke on die-casting, describing its range from lead to bronze and showing many interesting slides and samples. The present problem in the field, according to the speaker, is the insufficient supply of aluminum, most satisfactory material for die-casting—an industry, whose birth, only twenty years ago, evolved into one of our major technical developments.

The American Blitzkrieg Discussed Before Central Illinois

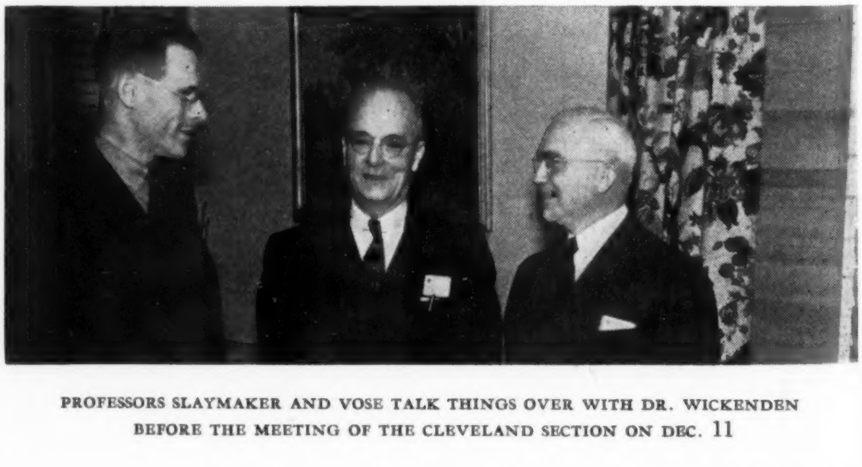
A. J. Colwell, president of the S.A.E., spoke on "The Blitzkrieg" at the Nov. 28 meeting of the Central Illinois Section. In his speech he praised the automotive engineer, who has given our armed forces speed and dependability on the ground and in the air, which factors eventually will lead to victory.

Central Pennsylvania Section Hears Congressman Van Zandt

At a joint meeting of the Central Pennsylvania Section and Centre County Engineers on Dec. 12, members heard Congressman James E. Van Zandt predict the establishment of a 10,000,000-man army, and 80,000-airplane air corps, and the greatest navy in the world loom as the country's future herculean task. When the present Navy construction program of 1943–1945 is completed, we will have a plethora of ships making ours the greatest navy in the world. The speaker stated the present lack of storage facilities for munitions and armaments has necessitated the slowing down of production, but this condition will soon be remedied, with production and management combining in the greatest war effort of all time.

Grand Strategy for Peace Discussed at Cleveland

Dr. W. E. Wickenden, president of the Case School of Applied Science, addressed 150 mem-



PROFESSORS SLAYMAKER AND VOSE TALK THINGS OVER WITH DR. WICKENDEN BEFORE THE MEETING OF THE CLEVELAND SECTION ON DEC. 11

bers and guests at the Dec. 11 meeting of the Cleveland Section on "A Peace Worth Fighting For." In his far-sighted address, Dr. Wickenden pointed out the necessity of a grand strategy for peace as well as for war, a strategy which must be conceived and put into effect immediately to insure lasting effects in peacetime, if our present economic setup is to survive.

Colorado Holds Joint Meeting With A.I.E.E. on Electricity

A joint meeting of the Colorado Section was held on Nov. 28 with the local chapter of the A.I.E.E. to hear Dr. Philip Thomas, of the Westinghouse Research Laboratories, address the group on the topic, "Electricity at Work." His vitally interesting speech on the new devices of recent scientific development in the field of electricity was copiously illustrated with models and movie demonstrations. Among the items treated was the Vortex gun, floating light, and fire-fighting robot.

Columbus Section Meeting Devoted to Aviation Talk

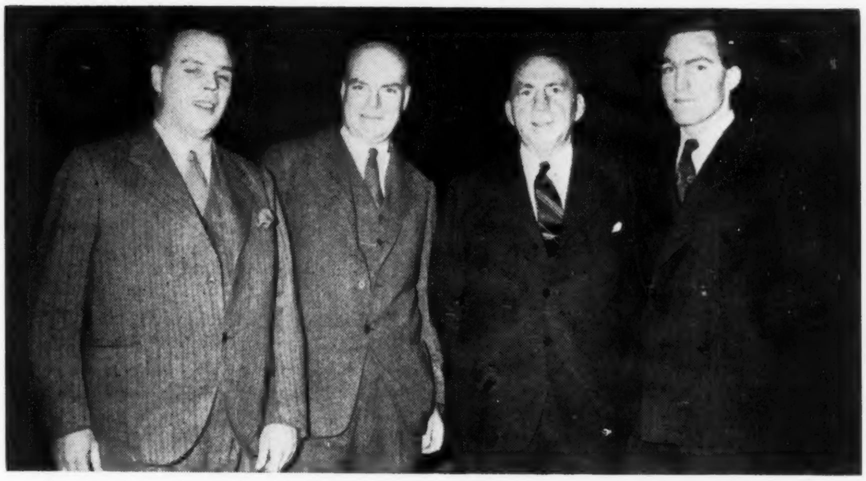
On Dec. 19, the Columbus Section held a meeting which was addressed by Barton T. Hulse, chief test pilot of the Curtiss-Wright Corporation, who spoke on his experiences as a test pilot as well as about his travels in China, the Philippines, and Malay States. His talk, of exceptional current interest, aroused lively comment and discussion. In addition a sound film was presented by K. H. Wickham of the public-relations department of Curtiss-Wright Corporation entitled, "The Building of the Curtiss-Wright P-40 Planes in the Buffalo Plant," which everyone enjoyed.

November Session of Detroit on Future of Power Generation

Before an audience of 250 members and guests present at the Nov. 25 meeting of the Detroit Section held at the University of Michigan, Ann Arbor, Mich., A. R. Smith, managing engineer of the General Electric Company, spoke on the "Future of Power Generation." In his talk, the speaker enumerated recent developments of power generation, recounting what had been accomplished in past years and what was being done today in modern steam and hydraulic power plants. He also briefly touched upon some of the more novel means of developing power which have been recently tried. Mr. Smith was qualified to speak authoritatively on his subject, having served for over forty years with the General Electric Company. In addition he is known the world over for his work in power-generation equipment.

Aviation Discussed at Erie Session, Nov. 18

The Nov. 18 meeting of the Erie Section was held at the Erie County Court House. Gerald W. Richardson, manager of the Port Erie Flying School, was guest speaker. His talk on "Aviation," covering flight training, flying light planes, and aviation instruments was both interesting and timely.



AT THE DETROIT SECTION MEETING, NOV. 25

(A. M. Selvey, Chairman Detroit Section; James W. Parker, President A.S.M.E.; A. R. Smith, speaker; and J. A. Templer, Chairman of the A.S.M.E. Student Branch of the University of Michigan.)

Structural Plastics in Aircraft, Address at Fort Wayne

The Fort Wayne Section, at its Dec. 11 meeting, heard R. L. Davis speak on the topic of molded plastics. In his interesting analysis, he pointed out the possibilities for the use of plastics in structural parts, but emphasized the fact that parts must be designed exclusively for plastics, rather than for a metal for which plastics are substituted without any design change. The speaker's talk, extremely illuminating, was copiously illustrated by a display of sample plastic parts.

Electricity From Wind, Subject at Kansas Section

The Dec. 19 meeting of the Kansas City Section started with dinner at the University Club. After the dinner Prof. Linn Helander gave an interesting report of the A.S.M.E. Annual Meeting in New York, which he had attended the first week in December. Later Prof. R. G. Kloiffler and Prof. Earl L. Sitz, of Kansas State College, presented a joint paper on "Kansas Winds as a Source of Electricity and Power."

Los Angeles Inspects Utility Fan Corporation

The Dec. 4 meeting of the Los Angeles Section took the form of a trip through the laboratories of the Utility Fan Corporation, where research work is under way on various types of heat exchangers and blowers. To further instruct the group, they were shown all of the manufacturing operations involved in constructing various heating and air-moving equipment.

Superchargers, Naval Aspects of Modern War, at Milwaukee

A joint meeting of the Milwaukee Section and the Milwaukee Junior Group was held Dec. 4 at the new Marquette Engineering Building. Two speakers were present. John Ryde, chief engineer of the McCulloch Engineering Corporation, spoke on "Modern Supercharger Applications," and illustrated his address with an exhibit of small superchargers. The second speaker, Commander L. O. Alford, U.S.N. and head of the R.O.T.C. unit at Marquette University, discussed "Some Naval Aspects of Modern Warfare." So absorbing were the topics presented that the meeting lasted until twelve o'clock.

Power of Plastics Outlined at Minnesota

A joint meeting of the Minnesota Section and the American Chemical Society was held on Nov. 24. The guest speaker was Dr. Howard L. Gilbert, research director of the Pittsburgh Plate Glass Company at Milwaukee. His talk, "The Power of Plastics," covered four main fields—synthetic glass, synthetic yarn, including nylon, and a new plastic, saron; synthetic rubber, today playing a vital part in our defense program; and general plastic applications. In conclusion, Dr. Gerhart pointed out that plastic automobiles and homes are still in the future, for in addition to the high cost of plastics today, no plastic yet developed has good weathering possibilities, accurate dimensional characteristics, or sufficient structural strength.

Films on Plastics and Neoprene Shown Nebraska Engineers

At the Dec. 10 meeting of the Nebraska Section, a total of 100 members and guests saw two sound films. The first, in color, presented a trip through the du Pont plant, portraying

the manufacture and processing of plastics, now destined to become of paramount importance in the manufacture of airplanes. The second film described the manufacture, advantages, and use of neoprene, a synthetic rubber in many ways superior to ordinary rubber because of its ability to withstand higher temperatures. Both films, informative and apropos, were enjoyed by all.

Bill of Rights and Chemistry at North Texas Session

Members of the North Texas Section on Dec. 9 heard a timely discussion on the history of the Bill of Rights and its present-day application delivered by Dr. J. F. Kimball. Following the talk, there was a brief discussion on the war. A du Pont film, "A New World Through Chemistry," completed the evening.

Ontario Learns About Fiberglas and Its Utilization

William B. Firner addressed the members of the Ontario Section at their Dec. 11 meeting on the topic, "Fiberglas and Its Importance to Industry." The speaker described the unusual manufacturing problems involved in producing glass fiber, which is only one thirtieth the diameter of a horsehair. Points were amplified through the display of Fiberglas products for thermal and electrical insulating requirements.

Present Shipbuilding Needs Discussed at Oregon

On Nov. 28, members of the Oregon Section heard talks by engineers from three of Portland's shipbuilding firms, The Commercial Iron Works, The Willamette Iron and Steel Corporation, and The Oregon Shipbuilding Corporation. Commander C. Hubbard, U.S.N., led the panel discussion by presenting an overall picture of present-day shipbuilding needs. The representative of each firm touched upon individual plant problems and their handling. An unusually interested audience engaged in a question period following the talks.

Manufacture and Development of Medium Tanks Described at Philadelphia

To a closed meeting of 225 members of the Philadelphia Section on Dec. 9, Captain A. J. Seiler of the Ordnance Department, U.S.A., chief of the industrial service, Philadelphia Ordnance District, showed films on the manufacture, construction, and operation of medium tanks, model M-3. Various features of design, namely, the virtues of welded versus riveted construction, and types and location of guns were detailed to the audience.

Rock River Valley Meets with Wisconsin Student Branch

At its Nov. 27 meeting, Rock River Valley Section welcomed members from the University of Wisconsin Student Branch. An audience of 64 heard the guest speaker, R. P. Koehring, metallurgist in charge of research and control of Moraine Propeller Division, General Motors, talk on the historical development of powder metallurgy. Present uses and limitations of both nonferrous and ferrous powder metallurgy constituted the body of the address, which proved extremely worth while to all those present.

San Francisco Discusses Problems of Industrial Lubrication

The Dec. 4 meeting of the San Francisco Section at the Engineers' Club attended by 85 members and guests featured Dr. W. J. Hund, Shell Development Company, who spoke on industrial lubrication and its problems. In his paper, Dr. Hund revealed interesting side lights on the differences in lubrication between grooved bearing surfaces and highly polished ones.

Machining of Shells, Topic at St. Joseph Valley Session

H. S. Dickinson was the guest speaker at the Dec. 16 meeting of the St. Joseph Valley Section. The topic of his talk was "The Machining of the 37-Mm Shell," in which he described the problems involved in machine design, stating that, in general, new machinery had to be made because of the impossibility of securing standard machine tools within the required time.

Safety Glass Discussed at St. Louis Meeting

An enthusiastic audience at the Nov. 28 meeting of the St. Louis Section heard John Weigh discuss the properties and applications of safety glass. The talk was illustrated by movies and actual demonstration of the nonshattering qualities of safety glass as compared with ordinary plate glass.

Utah Section Hears About Power Plant Slogan

On Dec. 11 members of the Utah Section heard A. D. Hughes outline the proposal for the study of unionization which the Local Sections Delegates had submitted to the Council of the A.S.M.E. Dr. Charles F. Parkinson spoke on management and labor co-operation in the national emergency. Particularly interesting was his description of "The Power Plant Operators' Association of the General Electric Company," whose slogan is "No Dues, No Strikes, No Shutdowns."

Virginia Section Holds Joint Meeting With V.P.I. Students

A joint meeting of the Virginia Section and the Student Branch at Virginia Polytechnic Institute was held Nov. 27. The first part of the program featured E. B. Norris, dean of engineering, who presented the Pi Tau Sigma keys to Floyd Fish and W. B. Houchins, a junior and a sophomore respectively, who attained the highest averages in the mechanical-engineering department in their respective classes. The speaker of the evening, Arthur Roberts, chief engineer of the Lynchburg Foundry Co., spoke on "Plant Engineering." He discussed the duties of the engineering department in a manufacturing organization and the duties of an engineer in an industrial plant. The meeting was concluded with the showing of two motion pictures.

Washington, D. C., Section Has Applied Mechanics Meeting

More than 90 members and guests of Washington, D. C., Section at the Dec. 11 meeting heard several papers on applied mechanics. R. Michel spoke on "Factors Influencing the Design of Marine High-Pressure Steam Piping," D. Windenberg talked on "Strength of Knees of Rigid Frames," and W. R. Osgood discussed "L-Shaped Plate Loaded by Couples in Its Plane and Application to Rigid Frames."

Joint Meeting With A.I.E.E. at Western Massachusetts

On Dec. 16 members and guests of the Western Massachusetts Section met jointly with the local chapter of the A.I.E.E. to listen to Lieut. Walter B. Loeffler, Hartford Ordnance District, and Maj. W. H. Weingar, chief of small-arms division, Ordance Department, discuss "Problems Encountered by the Ordnance Department." Some of the facts outlined by the speakers were the duties of the Ordnance Department which embraces the entire field of manufacturing from the raw material to the shipment of the finished products. The Major spoke further on the manufacture of guns, ammunition, and antiaircraft equipment, detailing reasons for the rigid specifications which must be imposed. Following the speech, the members held a question period and examined some of the ordnance equipment on display.

Paper on Bearings Presented Before West Virginia Section

The Nov. 25 meeting of the West Virginia Section featured as guest speaker, M. W. Petrie, production research chief, Chrysler Corporation, who spoke on "Bearings and Bearing Surfaces and Their Application to the Automotive, Aircraft, and Related Fields." In his talk, he discussed the process of superfinishing and the importance of fine surface finishes, and emphasized the many applications of superfinishing, especially that of the U. S. Government's adaptation of it to the manufacture of optical lenses for Army and Navy instruments. The talk, illustrated by slides, aroused many interesting comments and questions. Prior to the meeting a dinner in honor of Mr. Petri was held in the Daniel Boone Hotel.

With the Student Branches

A.S.M.E. Students to Write Biographical Sketches for Prizes

AT A meeting held in the Astor Hotel on Dec. 2, 1941, the Committee on Engineers' Civic Responsibilities of The American Society of Mechanical Engineers expressed satisfaction at the report of Mr. Walter Kidde, member of the committee, that he would continue the Walter Kidde Award of $50 each to the Newark College of Engineering and the Stevens Institute of Technology, and the report of Mr. Cullimore, chairman of the committee, that the donor of the A. A. Potter Award at Purdue had signified his willingness to continue that award.

It was felt that some further concrete suggestions concerning the participation of the three student branches of the institutions involved should be set up. It was suggested that the specifications for each essay should be the same, and it was felt that this essay should revolve quite definitely around a personality and should take a biographical form.

Mr. Kidde suggested that each student branch, instead of being allowed latitude in their choice, should write on the life of one man, to be suggested by the committee and meeting the approval of the donor. Such a treatment, it was believed, would not only enhance the interest in the award but would result in more interesting papers and, in general, a better quality of work.

Mr. Kidde indicated that if the student branch of the Newark College of Engineering could write on the life of John S. DeHart, Jr., and the Stevens Institute of Technology on Conrad Lauer, it would please him very much. Mr. Cullimore indicated that the donor of the A. A. Potter Award had expressed a desire to have the award this year based on the life of A. A. Potter.

In discussing the over-all values inherent in this method, it was felt quite definitely that a series of thumbnail sketches of engineers would be of value—sketches of engineers who are at present active or whose contributions could be viewed from the standpoint of their contemporaries, where material would be available at firsthand concerning the projects which they had furthered and the work that had been done. It was thought that this contribution might be extremely valuable in years to come and would be in such a form as to bring out all the interest which centers around an active, functioning personality.

It was the opinion of the committee that if we are dealing with younger men in the profession, the best examples that could be set would be of older men in the profession and that, while there might be some objection based on the opinions of individuals concerning their own worthiness, a series of sketches of this type presented from time to time in MECHANICAL ENGINEERING might be very effective. Young people like action, and contemporary leadership is more appealing than historic or abstract subjects.

Concerning the technique of transmitting the material to students, it was suggested that a simple method might be followed: A topical outline of the activities of the man whose sketch is to be written, arranged in chronological order, could be presented to the contestant as a basis for research; and it was not deemed impossible that the subject of the essay might consent to appear before a small group of a dozen contestants, to answer questions or to discuss informally those matters relating to participation in civic affairs that will be of interest to the contestants.

The idea back of this particular technique was that essays, in the main, on abstract subjects are not only uninteresting but have no satisfactory appeal to younger men whereas dynamic, active personalities have such an appeal. It was hoped to interest several of the local sections in the furthering of similar awards, particularly in the New England States, in the South, and on the Pacific coast. It was thought that three such awards might be well worth while. The chairman expressed considerable hope that such a proposition was possible. There seemed to be greater sensitivity to the war and postwar problems on the part of engineers. There was considerable evidence that local sections, notably in Detroit and Denver, were attempting projects which very definitely could be classed under the broad head of civic responsibilities, and it seemed only right and proper that these local sections should assume the sponsorship of one of the student branches in their particular localities with respect to engineers' civic responsibilities.—A. R. CULLIMORE.

An Engineer in Public Affairs[1]

BY ROMAN POPIEL

A MAN is born a citizen and he may become an engineer. Many an engineer, however, does not continue to be a citizen in the deeper sense. In a democracy such as ours, all citizens must take a positive interest in their government. Otherwise power passes by default from the citizens to whatever group does interest itself in the exercise of power, even though it may be to the detriment of the citizens.

Doctor Roy V. Wright is one engineer who has realized his obligations as a citizen and has more than fulfilled these obligations, without dimming his illustriousness as an engineer. Doctor Wright has gone far in public affairs. Besides participating actively in governmental affairs, he has given a full measure of energy to awakening in the minds and hearts of engineers everywhere a realization of their obligations and duties as citizens and their opportunities for service as engineers.

Thinking About a Career at Fifteen

When Roy Wright was fifteen years old, he was, like many boys, already looking ahead to the time when he must choose a career. Although he may not have been aware of his position at that time, he made his decision at a unique time in the history of this country, when one epoch ended and another began. In 1893 our physical frontiers were substantially fixed. Only a year was to remain in which a man might literally "go west" to new lands. Our spectacular era of territorial expansion, soon to become the subject of innumerable melodramas, was drawing to a close. But in Chicago the nation coming of age had erected the Columbian Exposition where, amid the splendor of synthetic Grecian temples, symbols of past glory, the new miracles of science, prophetic of future glory, were exhibited for the first time. Roy resolved to see this new Eldorado himself. After weeks of hard work and innumerable economies, he was able to afford traveling from St. Paul, his home town, to the fabulous World's Fair, where he remained a week. One can readily imagine with what awe he gazed at the new wonders of mechanics and invention. But behind the blinking electric lamps and the rotating wheels, the boy saw America's new frontier, the frontier of engineering progress, limited only by man's energy and ingenuity. Young Roy decided to become an engineer.

Upon graduation from high school, he worked his way through the University of Minnesota, from which he was graduated with a mechanical-engineering degree. Years later, in 1931, the honorary degree of doctor of engineering was conferred upon him by Stevens Institute of Technology.

Railroading the First Job

Roy Wright entered the railroad business immediately upon graduation from college. He was employed as machinist's apprentice in the locomotive erecting shop of the Chicago, Milwaukee, and St. Paul Railway at South Minneapolis. During the succeeding years he served this company and the Chicago and Great Western as apprentice, draftsman, and chief draftsman. He was a mechanical engineer for the Pittsburgh and Lake Erie Railroad during the period of early development of the all-steel gondola and hopper freight cars

[1] This biographical sketch of Roy V. Wright, past-president A.S.M.E., written by Roman Popiel, Newark College of Engineering, class of 1941, for the Walter Kidde Award referred to in the report by A. R. Cullimore, chairman, A.S.M.E. Committee on Engineers' Civic Responsibilities, also published in this section.—EDITOR.

for use on a large scale in the coal and steel districts. At this time he was one of the youngest railroad mechanical engineers in the country.

Later, Dr. Wright's knowledge of railroading gained him the position of associate editor of the *American Engineer and Railroad Journal.* Since that time he has managed several railroad-engineering publications. At present he is the managing editor of *Railway Age.* In his editorial career Dr. Wright has risen to a high place in the trade-paper field and now he holds the position of president of the Associated Business Papers. One of the activities of this society is interviewing political figures in Washington each month in connection with matters of business and government.

Good Citizenship a Lifelong Interest

Good citizenship includes not only political activity but also activity in associated clubs which definitely tie in with life in the community. Dr. Wright has long been active as a member of the Young Men's Christian Association in both an administrative and an advisory capacity. He presided at various educational forums conducted by the association. At present he is a director of the Y.M.C.A. of the Oranges (New Jersey). He has served on several national and international committees in connection with the Y.M.C.A. He has also been associated with the National Council of the Y.M.C.A. which furnishes homes for itinerant railroad workers and crews.

As a member of The American Society of Mechanical Engineers Dr. Wright has been tireless in his efforts to make engineers more conscious of nonindustrial activities. On the occasion of his induction as president of the Society in 1931, he reminded the engineers of the criticism they invited by their failure to think more about the future, what with the difficulties arising from the machine age. In the same address he urged the engineers to realize their civic responsibilities. He stated that, in the machine age, engineers were particularly suited to serve on advisory committees in the community. Because of his interests in this field, Dr. Wright has been an active member of the Committee on Engineers' Civic Responsibilities of The American Society of Mechanical Engineers since its appointment by A. A. Potter.

Several years ago the Polity Club, a civic-affairs group, was formed in East Orange, N. J. The first objective of this club was to recommend civic improvements and to help, in a general way, in installing these improvements. Since the club's membership consisted of young men whose political experience was very limited, it seemed advisable to invite some older men with broad experience in public affairs to act as advisers to the group. Having been active politically on the Board of Freeholders of Essex County (New Jersey) and the Republican State Committee, Dr. Wright was especially suited to aid these young men. With his characteristic enthusiasm for the affairs of young people, Dr. Wright has done much to strengthen this group, not only through his wise counsel but also by publicly backing the group in their campaigns for improvements. At present he is supporting a Polity Club campaign to set up an Official Planning Board for East Orange.

Encourages Others to Active Interest

In addition to his efforts in promoting good citizenship in his own community, Dr. Wright has presented lectures on this subject in several colleges. Notable among these is the Newark College of Engineering where he has given organized lectures for several years. The conviction and enthusiasm with which he presents his favorite topic, good citizenship, has certainly been responsible for the most serious thought about the matter on the part of the students. In collaboration with his wife, Dr. Wright wrote a book entitled "How to Be a Responsible Citizen." The book gives a very comprehensive analysis of the duties of a citizen and also tells of the best methods for fulfilling these duties. Dr. Wright's lectures and writings make it readily apparent that he is a firm believer in democracy. He is firmly convinced that the people *are* fit to rule themselves, in spite of the fact that not all of them have yet realized their actual importance to the democratic way of life. The force with which his talks are delivered indicates that within him is the hope of a glorious future for democracy in the United States of America.

After some forty-odd years of engineering and public activity, Dr. Wright has emerged, not a cynic, but an idealist. He has emerged an engineer who can discuss with ease the classics or yesterday's baseball game. He has emerged an engineer who has retained his sense of humor and his faith in living.

While others who speak to special groups stress the power these groups possess, Dr. Wright stresses the responsibilities of engineers. If there were men in all walks of life who were equally influential in inculcating social responsibility and the desire to serve, many of the strains in the body politic would be relieved or abolished altogether, to the immense benefit of our whole nation. America still has frontiers which will yield only to the common endeavor of responsible citizens. In 1941 Dr. Wright was elected State Senator from Essex County, New Jersey. He brings to the office not only his characteristic vigor and sincerity but an engineering background and no small contact with political affairs.

Acknowledgment

The author wishes to thank Mr. William Schmidt, associate editor of *Railway Age,* and Mr. Paul Nordt, Jr., mechanical engineer, for their assistance in finding the facts contained in this essay.

Branch Meetings

Akron for Improved Meetings

AKRON BRANCH conducted an evening meeting on Dec. 18 at which a proposed schedule of meetings and inspection trips for the coming year was presented. A general discussion of the schedule, suggestions, and ways of improving the service of the Branch took place.

ALABAMA BRANCH held its first evening meeting since the beginning of the school year on Dec. 11. The power shortage throughout the South prevented the holding of previous night meetings. About 50 members and guests heard talks by Prof. D. H. McCuaig and Dr. John M. Gallalee. Following the talks, motion pictures of the Alabama-Tulane football game was shown in order to demonstrate that team work in the engineering field is just as important as teamwork on the football field.

ARKANSAS BRANCH held a smoker at its Dec. 15 meeting, which featured three talks, the most interesting being that of Graham Noell, entitled, "The Lubrication of Small Watches." The address, illustrated by personal experiences, was followed by a discussion on current affairs. Refreshments were served.

ARIZONA BRANCH featured a paper on "Inspection in Industry" by W. C. Curry, faculty member, at the Dec. 3 session. His talk was very interesting since he based it on his recent experience with a machine-tool company.

BROWN BRANCH devoted its meeting of Dec. 10 to a report by Roy Roberts, chairman of the Branch, on his participation in the Annual Meeting of the A.S.M.E., and the showing of the motion picture, "Bridging San Francisco Bay," distributed by U. S. Steel Corp.

Installation Banquet at California

The last meeting of the semester of CALIFORNIA BRANCH was held on Nov. 26 at Bertola's Cafe. It took the form of a banquet at which new officers for the coming semester were installed. After a delicious meal, the guest speaker of the evening, Dean McLaughlin of the Colleges of Mining and Engineering, gave a talk on "Opportunities for Present Graduates in Engineering." The meeting was adjourned with the singing of "Hail to California."

SOME COLORADO AGGIES SHOWN BEFORE TWO-MILLION-LB DIAL-TESTING MACHINE

(The Student Branch of Colorado A.&M. visited the Bureau of Reclamation in Denver, Col., Nov. 1. Outstanding among the equipment for testing everything from soils to model dams was the department in which concrete was exhaustively experimented on.)

STUDENT BRANCH AT UNIVERSITY OF COLORADO

University of Colorado Branch held a joint meeting with the A.I.E.E. Branch on Nov. 26 at which more than 500 members and guests were entertained with a talk by Philips Thomas, member of the research department of Westinghouse Electric & Manufacturing Co., and a demonstration of certain scientific principles. The Dec. 3 session of the Branch was devoted to an illustrated lecture by Arthur Lyster, Socony-Vacuum Oil Co., on lubrication of bearings.

Colorado Mines Branch members took part in an interesting inspection trip on Nov. 29 when they boarded the new *Texas Zephyr* train in Denver, inspected it from end to end, and then rode in the engine to the yards. Here Prof. John C. Reed showed the boys the power plant and explained its operation.

Colorado A.&M. Branch met on Nov. 17 and heard a paper on the production of steel given by Elmer Bishard. Following a discussion on the paper, the members adjourned to the mechanical-engineering laboratory for refreshments.

Professor Gus Talks at Cooper Union

Guest speaker at the Dec. 10 meeting of Cooper Union Branch was Prof. Charles E. Gus, New York University, who spoke to the group on the subject of "Cartoons and Visual Aids in Teaching Engineering." He explained the method employed by him in making animated drawings and then showed films dealing with such subjects as kinematics, machine design, polarized light, and aerodynamics.

Cornell Branch presented the motion-picture film, "Wright Builds for Air Supremacy," to 95 members and guests at the Dec. 9 meeting. The film was preceded by a talk given by G. Cole of the Wright Aeronautical Corporation.

Duke Branch welcomed Prof. A. G. Christie, past-president of the A.S.M.E., to its Nov. 12 meeting. He addressed the branch on the subject of "Water and Power for the City of Los Angeles," covering the history of the problem of water and power for this vital port.

Florida Branch discussed and completed various items of business at its Dec. 5 meeting. This was followed by the photographing of the group.

George Washington Welcomes Alumnus

W. H. Seaquist, chief of the section of design and construction at the Bureau of Standards and an alumnus of the school, was the guest speaker at the Dec. 3 session of George Washington Branch. His topic was "The Future of the Engineer in Design and Construction." A spirited and interesting discussion followed his talk.

Idaho Branch held a "shop picnic" in the mechanical-engineering laboratory on Dec. 3. All new students taking mechanical engineering were invited to attend. During the evening, various types of steam and internal-combustion engines were demonstrated and explained. The main purpose of this meeting was to provide an opportunity for the students and instructors to become better acquainted. Refreshments were served.

Illinois Tech Branch and the student chapter of the A.S.C.E. conducted a joint meeting on Nov. 7 at which the motion picture, "Land of the Free," was shown through the courtesy of the Chrysler Corporation. The film depicted the United States of America—its unmatched economic resources, its growth and development, and its blessings of liberty. Another film, "Army on Wheels," was also shown.

Illinois Branch members at the Dec. 3 session nominated officers for the coming semester. This was followed by a talk on the Allison aircraft engine presented by John Goldwaite, Allison Division of General Motors. In keeping with the spirit of the times, he opened his talk by saying that all engineers should learn to appreciate our country which has done so much for us.

Iowa State learned all about the O.P.M. and its workings from George Beese, head of the Iowa branch of the O.P.M. and Iowa State graduate of 1924. Especially interesting was an explanation of the methods utilized in expediting the manufacture of munitions in the various plants scattered throughout the state.

Iowa Discusses Military Aviation

John Lundquist, a member of the mechanical-engineering faculty, spoke on the subject of "The Military Aspects of Aviation," at the Dec. 17 meeting of Iowa Branch. He outlined the many problems confronting manufacturers of airplanes and aircraft engines for the specialized tasks encountered in military performance, and how certain equipment had been developed to simplify the work of the pilot.

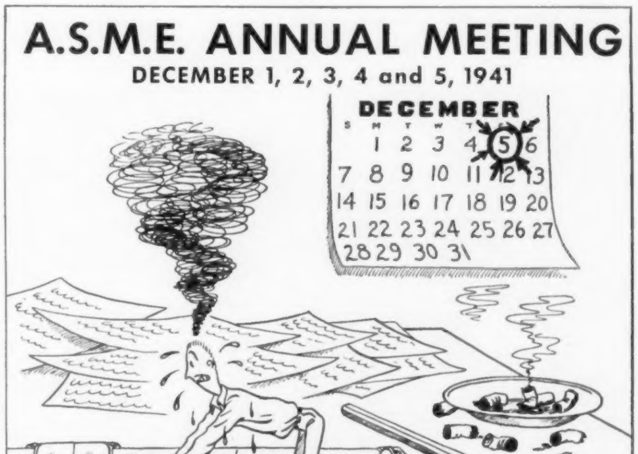
Johns Hopkins Branch met on Nov. 26 to listen to Henry H. Snelling, past vice-president of the A.S.M.E., who spoke on the subject of inventions. He explained the procedure of patenting an invention.

Intelligent Engineers at Kentucky

Dr. Martin White, of the psychology department, told the more than 80 members of Kentucky Branch at the Nov. 21 meeting that "the intelligence of engineers was very

THE SLIDE-RULE PUSHER OR WHY THE PRINCETON SENIORS DID NOT ATTEND THE 1941 A.S.M.E. ANNUAL MEETING

(Drawing by William Bush, Jr., who with his fellow sufferers faced an examination on Dec. 5.)



VIRGINIA POLYTECHNIC INSTITUTE STUDENT BRANCH

much higher than any other group or profession." He stated that engineers have not only distinguished themselves in their own field but also in other fields.

575 at Maryland Meeting

MARYLAND BRANCH and its 75 members were hosts to more than 500 student members of the A.I.E.E., A.S.C.E., A.I.Ch.E., and S.A.E., at the Nov. 12 meeting. The speaker was Dr. John E. Younger, head of the department of mechanical engineering at the University, who described the development, construction, and use of monocoque construction of airplanes.

MICHIGAN BRANCH was host to more than 250 members and guests, many of whom were from the Detroit Section of the A.S.M.E., on Nov. 25. A. R. Smith, managing engineer of the turbine department of General Electric Co., spoke on "The Future of Power Generation." Notable among the guests were James W. Parker, the new president of the A.S.M.E., and A. M. Selvey, chairman of the Detroit Section. Mr. Smith's talk dealt chiefly with the new and unusual methods of power generation and the possibility of these methods becoming future sources of power.

MICHIGAN STATE BRANCH had the E.C.P.D. paper by Prof. Charles F. Scott, entitled, "The Student Branch Looks Forward to Professional Status," read to the members at the Dec. 4 meeting. After a discussion of the paper, a short musical quiz program and a talk by Donald L. Gibb, Dow Chemical Company, on the properties and future of plastics comprised the balance of the program.

MISSISSIPPI STATE BRANCH was host to 30 members and 140 guests on Dec. 4 at the presentation of the motion-picture film, "Steel—Man's Servant." In a fascinating and instructive manner, the film related the story of the process of steel manufacture from the ore to the finished products.

NEBRASKA BRANCH presented a paper by student member Roy McDonald on mobile applications of air conditioning at the Dec. 3 meeting. Slides showing an air-conditioning unit installed in an automobile were used to illustrate the paper.

Air Offense and Defense at N.Y.U.

Prof. Frederick K. Teichmann, honorary chairman of the N.Y.U. BRANCH (aeronautical), was the guest speaker at the Dec. 19 meeting of the Branch. His address dealt with military aircraft, its uses and methods of defense against it. Sound locators and radio locators are the two pieces of equipment utilized for the detection of enemy aircraft, with the latter type being the most efficient. As an example of the infallibility of the former type, Professor Teichmann showed how a bomber at a height of 25,000 ft can cut its engines and glide over its target silently. Today, a 20-ton bomber costs at least $800,000 and its bomb load will be worth about $500,000.

STUDENT BRANCH OF '41-'42 AT ROSE TECH

NEWARK BRANCH featured as speaker at the Nov. 13 meeting William R. LaMotte, assistant general superintendent of electrical generation of the Public Service Company of New Jersey. He told the group of 150 members and guests the vital part being played by steam-power plants in the National Defense Program.

NOTRE DAME BRANCH presented at its Dec. 5 session motion pictures on the processing of steel. This was followed by a talk by C. R. Egry, honorary chairman, on the reasons why student members should write and present technical papers at the meetings of the Branch.

OHIO STATE BRANCH at its Dec. 5 meeting passed a hat around and $7.20 was finally given to the Y.M.C.A. to use for its Christmas charity fund. A movie on the construction of Golden Gate Bridge was shown.

Variety Program at Oklahoma

Plenty of variety can be found in every program sponsored by the OKLAHOMA BRANCH. At the Dec. 11 session, John Slajer gave a paper on "Gas Turbines," John Lesch showed colored movies of the homecoming parade, and Gene Kennedy played the piano.

PITTSBURGH BRANCH holds weekly meetings, the majority of which feature papers by student members. At the November and December meetings, papers were given by John Knoll, Paul Carney, Richard Roberts, Clark Morris, James B. MacPherson, and John Bitner.

PRATT BRANCH at its meeting of Nov. 27 had as speaker Walter Moen, faculty member, who talked on "Heat Transfer." On Dec. 11, T. Apjohn, Socony-Vacuum Company, gave a paper on "Oil and Gas Power," in which he described the various uses of crude oil and the derivation of petroleum.

PRINCETON BRANCH met on Dec. 9 and showed to its members the motion picture, "Wright Builds for Air Supremacy." After a question period, the meeting was adjourned and refreshments were served.

Weekly Meetings at Purdue

As part of a new program policy, PURDUE BRANCH is now featuring weekly meetings. The first, held on Dec. 2, featured papers by Warren James on propellers and by George Topinka on propeller maintenance. The Dec. 10 session had a movie entitled, "A Study of

Gears," procured from the University of Iowa and dealing with the design and manufacture of various types of gears. On Dec. 16, Kenneth Harker gave a talk on radio-controlled airplanes and illustrated his talk with a flying radio-controlled ten-foot gas-model airplane.

RICE BRANCH's secretary, Richard R. Bloss, at the Dec. 3 meeting described the technique and problems in obtaining a private airplane-pilot's license, based on his own experience.

ROSE POLY BRANCH featured student papers at the Nov. 3 session. Eugene Hess spoke on "Airplane Reduction-Gear Testing," and Eugene McConnell gave the history of the Allison aircraft engine.

SANTA CLARA BRANCH had papers given by student members at the Nov. 27 meeting. Philip Stephens and William Houle both gave talks on manufacturing processes.

SOUTHERN METHODIST BRANCH had a three-part program at its Nov. 24 meeting. The showing of a motion picture on the River Rouge plant of the Ford Motor Company was followed by a discussion on Engineer's Day, led by M. V. McDonald. Finally, the group adjourned to the mechanical-engineering laboratory where coffee and doughnuts were served.

TENNESSEE BRANCH on Nov. 20 featured a program by Robert Black, who showed motion pictures on "Motion Study" and "Motion Pictures in Industry." At the Dec. 4 session, Professor Tucker discussed the presentation of student papers at A.S.M.E. meetings and Professor Morton gave a very interesting talk on streamlined locomotives.

TEXAS TECH BRANCH had John Emery, Ethyl Gasoline Corporation, as the guest at the Dec. 15 meeting. He exhibited two motion pictures, "What Is Good Tune-Up?" and "What Is Good Gasoline?" and then gave a demonstration of the performance of different grades of gasoline with a working model of a gasoline engine.

Student Paper at Tufts

Frank J. Butler, student member, spoke on "Friction as a Factor in Bearing Design" at the Dec. 17 meeting of the TUFTS BRANCH. He explained the theory of static friction, as developed by the Cincinnati Milling Machine Co., and showed the relationship of surface conditions to bearing-load capacities and tool speeds. Also traced was the development of profilograph surface measurements and superfinishing. A discussion period followed.

V.P.I. BRANCH held its annual fall joint meeting with the Virginia Section of the A.S.M.E. on Nov. 27. Arthur Roberts, chief engineer of the Lynchburg Foundry Company, spoke to the meeting on plant engineering. The meeting was concluded with two motion pictures, one showing the centrifugal-cast iron pipe process, and the second concerning water sanitation, purification plants, and sewage-disposal plants.

WASHINGTON BRANCH had Prof. Lloyd R. Koenig as guest speaker at the Nov. 24 meeting. The title of the talk was "A Day in the U. S. Patent Office," a subject of special value to a student engineer who sooner or later will meet with patent problems.

Worcester Alumnus Lost at Pearl Harbor

At the Dec. 17 meeting, Chairman Peter P. Holz of the WORCESTER BRANCH called for a short period of silence in memory of Theodore Bates, a past-chairman of the Branch, who lost his life in the Japanese assault on Pearl Harbor. The meeting then continued with papers by George D. Williams and John M. Townsend.

YALE BRANCH brought up various items of business at the Dec. 9 meeting. One item discussed was the joint meeting with the New Haven Section on Feb. 17. Another item was the mechanical-engineering show on Feb. 20 and 21. Dean S. W. Dudley then discussed the probable and announced effects that the war will have on mechanical-engineering students. For those who feel called upon to enter the armed services, midyear degrees will be made possible by taking special examinations covering the work actually completed. Finally, reports of the Annual Meeting of the A.S.M.E. were given by Josephs, McAndrews, Clark, and Aust.

John Jefferies Award to Major H. G. Armstrong

MAJOR Harry G. Armstrong, U. S. Army Medical Corps, in charge of research at the School of Aviation Medicine, Randolph Field, Texas, has been named to receive the John Jeffries Award given by the Institute of the Aeronautical Sciences.

The John Jeffries Award, given annually "for outstanding contributions to the advancement of aeronautics through medical research," will be conferred on Major Armstrong in recognition of his pioneering studies done on the physiological and psychological effects of flying at high altitude and in high-speed maneuvers. He was one of the first to recognize and accurately describe some specific medical results of flying, such as aeroneurosis, a kind of mental and physical fatigue experienced by fliers under certain conditions; aero-otitis, an effect of high altitude and acrobatic flying on the human middle ear; and aeroembolism, a reaction similar to the "bends" suffered by deep-sea divers which affects pilots who climb to high altitudes too rapidly and without proper safeguards.

Most of his researches on the physiological effects of low barometric pressure, low temperature, and lack of oxygen were carried out in the high-altitude test chamber of the Aero Medical Research Unit at Wright Field. Major Armstrong customarily made himself the first human subject for a new test, often under experimental conditions which were dangerous to his own life. His work has done much to stimulate further research in the medical aspects of aviation and has led to the development of oxygen supply and pressurizing apparatus and other precautionary devices and procedures for safeguarding pilots against the physical effects of modern military flying. Numerous reports on his work have been published in medical and aeronautical journals. His book on "Principles and Practice of Aviation Medicine" is said to be the most complete and authoritative text yet published on the subject.

The award is named after Dr. John Jeffries, a Boston physician, who was the first American to make scientific observations from the air. He made a flight from London with Blanchard, the French balloonist, in 1784, and took recordings of the temperature, humidity, and density of the air. In January, 1785, Dr. Jeffries and Blanchard made the first crossing of the English Channel by air.

Index to 1941 Volume of Mechanical Engineering

As Part 2 of the January, 1942 issue of the Transactions of the A.S.M.E., separate indexes to the Transactions and to MECHANICAL ENGINEERING for 1941 were mailed to the A.S.M.E. membership.

An additional copy of the index to MECHANICAL ENGINEERING may be secured from A.S.M.E. Headquarters, 29 West 39th Street, New York, N. Y., by sending ten cents for handling charges.

Hibbard Heads I.A.S.

HALL L. HIBBARD, vice-president and chief engineer of Lockheed Aircraft Corporation, Burbank, Calif., has been elected president of the Institute of the Aeronautical Sciences for the year 1942, it was announced yesterday. He succeeds Frank W. Caldwell, director of research of the United Aircraft Corporation, Hartford, Conn.

Mr. Hibbard is responsible for the design of a long series of Lockheed airplanes which are noted for their speed and military excellence. He helped in pioneering the development of the twin tail and the single-spar all-metal airplane wing. His designs have used increasingly heavy wing loadings and include an experimental tail-first or canard type of airplane. In the development of air transport types and the Army's famous stratosphere airplane, his work has been outstanding.

A.S.M.E. Machine Shop Practice Division Now Production Engineering

AT the December 1 meeting of the Executive Committee of the Machine Shop Practice Division there was a unanimous decision to recommend to the Council a change in name of the Division to Production Engineering. This matter was submitted to the Council on December 5 and the change in name was approved. The chairman of the Division is Sol Einstein and the secretary, Warner Seely; other members of the executive committee are: J. M. Alden, E. W. Ernest, Erik Oberg, and C. L. Tutt, Jr., staff assistant. It is anticipated that several other members representing industry will be added to the Committee this year. Associates of the Division are Hans Ernst, A. M. Johnson, and E. D. Waters. The Executive Committee is now developing the objectives of this Division and a well-rounded program. As the plans develop in this field they will be announced in subsequent issues of MECHANICAL ENGINEERING.

A.S.M.E. Local Sections

Coming Meetings

Cincinnati. February 26. Noon, luncheon meeting. Subject: "Bridges and Aerodynamics With Special Reference to the Failure of the Tacoma Narrows Bridge," by David B. Steinman, consulting engineer, New York, N. Y.

Chicago. February 26. The Chicago Section will participate in the Washington Award Dinner and presentation with the other engineering societies at the Union League Club. William L. Abbott, past-president of A.S.M.E. and of the Western Society of Engineers, will be the recipient. Dr. Arthur C. Willard will deliver the principal address.

Columbus. February 27. Same as Cincinnati.

Dayton. February 28. Same as Cincinnati.

Detroit. February 3. At the Horace H. Rackham Educational Memorial, Detroit, Mich. Subject: "New Automatic Telephone Exchange for Detroit," by J. D. Tebo, Bell Telephone Laboratories, New York, N. Y., and H. G. Mehlhouse, Western Electric Co., Chicago, Ill.

Ontario. February 12. Hart House, Toronto, Ont., Can. Subject: "Gaging," by O. W. Ellis, Ontario Research Foundation.

St. Joseph Valley. February 14. Joint Dinner Dance with American Institute of Electrical Engineers, Michigan Power Engineers, and American Society of Civil Engineers. The big social event of the winter.

St. Louis. February 26. Joint Meeting with engineers Club of St. Louis to be held at 4359 Lindell Boulevard, at 8:00 p.m. Subject: "Modern Technique in Attacking Industrial Water Problems," by Ralph E. Hall, Director of Hall Laboratories, Inc., Pittsburgh, Pa.

Susquehanna. February 13. Dinner Meeting and Lecture.

Toledo. February 24. Same lecture as at Cincinnati.

Washington, D. C. February 12. Potomac Electric Power Company Auditorium, Wash., D. C. Phillips Thomas of the Westinghouse Research Laboratories will address the Section on "Adventures in Electricity."

Worcester. February 10. Round-table discussion on the subject of management.

R. F. Hays, Jr., Gets Alfred Noble Prize

THE Alfred Noble Prize for 1940-1941 has been awarded to Robert F. Hays, Jr., for his paper, "Development of the Glow Switch," which was published in the May, 1941, issue of *Electrical Engineering.* This prize is awarded annually during the year ending June 1, to a member of the A.S.C.E., A.I.M.E., A.S.M.E., A.I.E.E., or the Western Engineering Society for a published technical paper of exceptional merit. The author of the paper must not have passed his thirtieth birthday. The prize was established in 1929 through a fund contributed by friends of Alfred Noble, past-president of A.S.C.E. and famous as a bridgebuilder, who died in 1914.

W. H. McBryde Reports on Personnel Service

IN A report made on Dec. 5, 1941, to the Council of The American Society of Mechanical Engineers on the work of the Engineering Societies Personnel Service, Warren H. McBryde, past-president of the Society, said that in spite of the great amount of special work which the Service had been called upon to do during the last year and for which it had received no compensation or fees, it had been entirely self-supporting over a period of twelve months for the first time in its existence.

Mr. McBryde explained that The American Society of Mechanical Engineers, in co-operation with the other Founder Societies, had for almost a quarter of a century successfully operated a personnel service with offices located in New York, Chicago, San Francisco, and a more recently established office in Detroit, for the solution of the personnel problems of its members. These offices, he said in his report, were fully staffed with a group of men whose well-rounded experience in the engineering field qualified them to deal intelligently with the many problems of technical employment.

"While great stress is placed upon the finding of positions for the unemployed Society members," the report continued, "this is but one of the many functions of the staff, as the Service is often called upon to a large degree to act as consultants in the personnel difficulties of its members. Such problems as aiding in company wage standardization, advising regarding market supply for future employment, surveys of men available in specified areas, vocational advice to recent graduates, and personal advice to disgruntled or dissatisfied employees are a few of the many problems with which the staff is faced."

Available Engineers Are Becoming Scarce

"Unemployment being such a changeable factor, it has been necessary for the Service to readjust its method of operation to meet the constantly changing conditions in the field. Recently, problems of unemployment have completely reversed themselves, at least in regard to supply and demand. Where it was necessary a few years ago to search a well-supplied market for a man having all the itemized qualities of the high specifications set by employers of that period, now adjustments have been made to search through a greatly depleted supply of man power for an engineer who may have a few of the qualifications specified.

"Naturally, the files of available engineers registered with the Service, have suffered greatly, and this has placed an added and constantly increasing burden on the staff. The present army induction program, which has taken many graduates of technical colleges directly from the campus to army training quarters, has cut appreciably the normal supply of men who annually enter the engineering profession, and in order to meet this increasing demand for engineers, it has been necessary for the Service to try to get the employers to accept into their organizations, men who were not directly trained in a branch of engineering in which the employer has operated. Extra caution must be practiced in the selection of men, long hours of interviewing are required to permit a thorough examination of each applicant's complete capabilities, and considerable sales effort on the part of the staff to convince the prospective employer to accept a 'not made to order' applicant has been necessary."

Personnel Furnished for National Defense

"The Engineering Societies Personnel Service is proud of the part it has played in our National Defense Program. It has co-operated with all branches of the governmental service and has even co-operated with the Army and Navy, in furnishing commissioned personnel in the regular armed forces of our country. A great number of qualified engineers for key positions in many governmental and important defense industries have been placed by the Service. A partial list of governmental agencies who have called upon and received aid through this Service is as follows:

U. S. Army

U. S. Army Construction Quartermaster Corps
U. S. Army Ordnance Department
U. S. Army Engineers Office
U. S. Army Signal Corps

U. S. Navy

U. S. Navy Supervisor of Shipbuilding
U. S. Navy Engineering Experimental Station
U. S. Navy Bureau of Yards and Docks
U. S. Navy Yards in Brooklyn, Philadelphia, Norfolk, Charleston

Other Agencies

Office of Production Management
Office of Price Administration
Office of Emergency Management
Panama Canal
U. S. Bureau of Mines
U. S. Department of Agriculture
T. V. A.

"This Service has also supplied engineers to a vast majority of the ordnance plants throughout the country, and to the defense projects throughout the world. Through the efforts of this bureau, our engineers are now employed in constructing air fields, naval, and military bases in Iceland, Greenland, Ireland, the West Indies, North Africa, and at practically all of the Central and South American outposts."

Wartime Requirements for Specialized Personnel

THE appointment of a special committee, entitled "A Committee on Wartime Requirements for Specialized Personnel," has been announced by the National Resources Planning Board. This committee will function as a part of the National Roster of Scientific and Specialized Personnel, of which Dr. Leonard Carmichael is Director. The committee is being convened under Dr. Carmichael's chairmanship.

The names of the committee, announced by

(Continued on page 168)

THE DANGER LIES AT THE TURNS

Accidents lurk when power and speed crowd *PIPING TURNS* too!

In 6-day bicycle races, if riders come to grief—it's usually on the turns where speed and strain increase the danger.
(I.N.S. photo)

Weld piping with TUBE-TURN fittings to prevent trouble at the crucial spots!

It takes strength and stamina to withstand the grueling pressure of a 6-day bike race, but that's nothing to the strain and stress imposed on many piping lines. The greatest concentration of pressure in pipe lines is placed on the turns—*wherever there is a change of flow direction.* Tube-Turn fittings are engineered for added protection *where the danger lies*—wherever elbows, returns, tees, reducers, laterals, nipples and flanges are used. You will find a type, size and weight of Tube-Turn fitting for *every* pipe welding need. Look for the Tube-Turn insignia welded on each fitting.

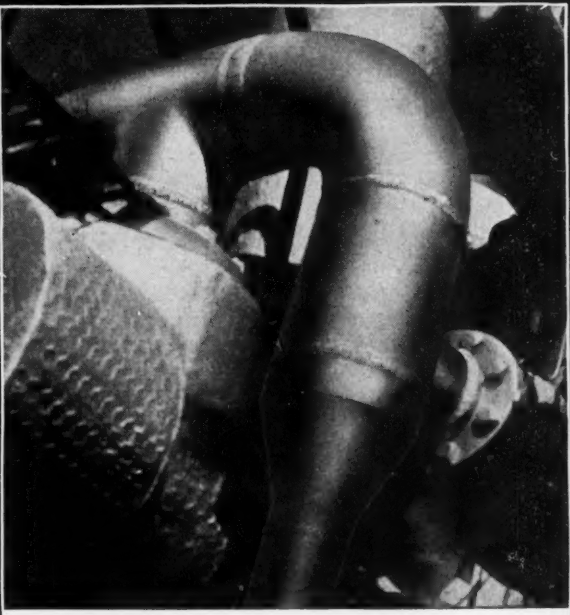
Write for Tube-Turn engineering data book and catalog.

TUBE-TURNS
INCORPORATED
LOUISVILLE, KY.

Branch offices: New York, Philadelphia, Chicago, Pittsburgh, Cleveland, Tulsa, Los Angeles. *Distributors everywhere.*

TUBE-TURN *Welding Fittings*
TRADE-MARK

HOW TUBE-TURN FITTINGS PROTECT WHERE FLOW DIRECTIONS CHANGE



This compact piping installation illustrates four common points that occasion *changes in flow direction*—a welding tee at the top, then a 90° elbow, a reducing outlet welding tee at the right, and a concentric reducer near the bottom. Tube-Turn welding fittings are used here to guard against danger at these turns.

Frederic A. Delano, chairman of the National Resources Planning Board, are:

Leonard Carmichael, chairman.
Edward C. Elliott, president, Purdue University.
Marion B. Folsom, treasurer, Eastman Kodak Company.
Guy Stanton Ford, ex-president, University of Minnesota.
Brigadier General Lewis B. Hershey, director, Selective Service System.
Edward F. McGrady, Special Adviser to the Secretary of War.
Mons. John A. Ryan, National Catholic Welfare Council.
John W. Studebaker, Commissioner of Education, Federal Security Agency.
Baldwin M. Woods, member A.S.M.E., University of California.
Owen D. Young, honorary member A.S.M.E., board of directors, General Electric Company.
James C. O'Brien, executive officer of the National Roster of Scientific and Specialized Personnel, will act in a similar capacity for the work of this committee.

Heavy Demands From Defense Agencies

The demands of the Army, the Navy, and specialized defense agencies having jurisdiction over highly technical matters have caused an unusually heavy drain on specialized personnel. Private industry, as well as government, has been calling for more and more specialists from the colleges, technical schools, and universities. There have been serious depletions in the ranks of technical teachers, professors, and research associates. Finally, the increased requirements of the armed forces anticipated under wartime conditions require the defining of adequate policies in the utilization of limited numbers of specialists. The committee is being asked to formulate recommendations with regard to these various problems and report to the National Resources Planning Board as quickly as possible.

It was also indicated that Administrator Paul V. McNutt of the Federal Security Agency has undertaken a still wider review of the available man power and its proper utilization during the war. The National Resources Planning Board's undertaking will be correlated with the closely related activity of Administrator McNutt.

National Roster of Scientific and Specialized Personnel

The National Roster of Scientific and Specialized Personnel, in which A.S.M.E. members have been given an opportunity to register, was originally organized to aid in the effective mobilization of scientific and professional skills and to conserve and direct those skills toward their most effective work. It has been functioning actively for the last eighteen months. It has a file of over 250,000 persons, and has supplied over 65,000 names to various defense agencies and defense industries. More than fifty scientific and professional fields are represented on the Roster. Detailed information concerning a large proportion of the country's scientists and professionally qualified individuals is centralized in the National Roster.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient, nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
29 W. 39th St.	211 West Wacker Drive	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

PLANT ENGINEER, 26, graduate mechanical engineer from University of Cincinnati. Two years' experience plant engineering, involving material handling, structural steel, concrete, machinery. Prefers southwestern Ohio. Now employed. Me-725.

MECHANICAL ENGINEER, 24, desires placement with progressive firm. Apprenticed machinist and engine mechanic; full of ideas and creativeness. Varied factory and engineering experience in addition to teaching, writing, and administration. Likes to get dirty. Me-726.

MECHANICAL ENGINEERING EXECUTIVE with wide experience in design, application, servicing of compressors, Diesel engines, and associated equipment. Has had active charge of design department for ten years. South or East preferred. Me-727.

GRADUATE MECHANICAL ENGINEER, 33, married. Broad experience in heavy machine and engine design, testing, and production. Has charge new machinery development. Executive ability. Fine personality. Permanent connection desired in Central West. Me-728.

MECHANICAL ENGINEER, 24, B.S. degree, 1940, Penn State. Desires position requiring initiative and responsibility doing research, testing, or design in field pertinent to mechanical engineering. Now employed. No location preference. Me-729.

MECHANICAL ENGINEER, 31, single. Foreman of instrument-repair department in large petroleum refinery. Experienced in selection and application of new instruments as well as instrument repair. Me-730.

MECHANICAL ENGINEER, M.I.T. graduate, 27, limited experience. Desires permanent position with large or medium-sized manufacturer for development work in an industry where thorough knowledge of thermodynamics, combustion problems, heat-transfer, and machine designing is essential. Me-731.

INDUSTRIAL ENGINEER, 33, U. S. citizen, A.B. and A.M. degrees, N. Y. license; 7 years' experience as consultant with medium-sized manufacturing plant; seeking responsible managerial or liaison work in New York area; will travel. Me-732.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

FURNACE ENGINEERS. Competent to design continuous furnaces for high-temperature heat-treatment. Salary, $4800 a year, and up. Pennsylvania. Y-9575.

CIVIL OR MECHANICAL ENGINEER, with nine or ten years' experience in design and manufacture of wood shipping containers, including boxes and crates, in testing of shipping containers, in carloading, and blocking of heavy equipment and machinery. Salary, $3800–$5600 a year. Middle West. Y-9586-C.

MECHANICAL DESIGNER, five to ten years' experience in design of forgings for production plant. Salary, $3900–$4420 a year. New York metropolitan area. Y-9593.

CHIEF OF PRODUCTION CONTROL, industrial engineer with considerable experience in line production. Must be good organizer as he will be the liaison between manufacturing unit and the executive management. Salary, $7200–$7500 a year. Middle West. Y-9595-C.

INDUSTRIAL ENGINEERS, with some previous experience in production control, preferably in an assembly plant. Work will consist of line production for shell-loading plant in Middle West. Salary, $5000–$6000 a year. Y-9596-C.

DEVELOPMENT ENGINEER, with at least ten years' experience in the metals-forming industry. Must know sheet forming, metal stamping, forging, casting, etc., and be able to develop mechanical equipment, tools, dies, etc., for production purposes. Knowledge of glass-to-metal adhesion beneficial. Permanent. $5000 a year. New York State. Y-9601.

ENGINEERS, graduate mechanical or chemical, with at least five years' experience in design of industrial and chemical plants. Will supervise design and layout of ordnance plants. Salary open. New England. Y-9606.

PLANT MANAGER with considerable experience in responsible charge of plant operations. Should be thoroughly familiar with rough-turning and hollow grinding operations, and have knowledge of heat-treating and forging. Salary open. Middle West. Y-9616-D.

(Continued on page 170)

MECHANICAL DRAFTSMAN with experience in design section of manufacture of industrial instruments. Company needs man thoroughly acquainted with the problems of this type; also a junior draftsman, with about a year's experience. Permanent. Salary, $3000 a year. New York metropolitan area. Y-9633.

MECHANICAL DESIGNER, 35–45, who can work up ideas on the board without supervision. Experience in hoists or elevating machinery beneficial. Permanent. Salary, $2500–$3200 a year. New York, N. Y. Y-9637.

MECHANICAL ENGINEER executive type with good background in machine-shop practice. Will have to do some expediting and estimating. Salary open. New Jersey. Y-9638.

MAINTENANCE ENGINEER, graduate mechanical, to take charge of milk-equipment-maintenance work. Force consists of machinists, tinsmiths, electricians and pipe fitters. Work involves upkeep of milk equipment, such as bottle washers, milk fillers, bottle conveyers, electric-motor drives, etc. Should have analytical mind and be able to ferret out the causes of breakdowns and recommend methods of overcoming them. Salary open. New York metropolitan area. Y-9645.

MECHANICAL ENGINEERING INSPECTOR, 35–60, with some experience in precision-gage work in machine-shop practice. Will act as administrative assistant. Salary, $3200–$3800 a year. New York, N. Y. Y-9677.

MAINTENANCE ENGINEER qualified to act as erection engineer in construction of a new chemical plant. Must know piping, kilns, conveyers, tanks, etc. Some design experience helpful. Must be U. S. citizen. Salary, $5000–$7000 a year. Middle West. Interviews, New York, N. Y. Y-9680.

SPECIALIST IN TOOL AND DIE MANUFACTURING. Must be familiar with design, construction, and use of pierce, blanking, bending, drawing, progressive types used in connection with cold-roll steel, phosphor bronze, stainless steels, and silicon electrical sheet, also jig and fixture designs. Pennsylvania. Y-9693.

DESIGNER, 40–50, with experience on valves and fittings to act as product-development engineer. Must have creative mind and be able to co-ordinate ideas with production. Permanent. Salary, $3000–$3600 a year. New York State. Y-9699.

JUNIOR ENGINEERS, civil, electrical, architectural, mechanical, and automotive, for War Department. Must be a graduate of recognized college. Duties are: To have charge of conducting proof tests of ammunition, artillery matériel, automotive matériel, and accessories; to interpret directives for tests; to plan work required; to design special laboratory apparatus for special tests and research studies; to submit concise reports on behavior of matériel and recommend changes in design. Salary, $2000 a year. South. Y-9700.

GRADUATE MECHANICAL ENGINEER, about 40, to supervise and take charge of mechanical-electrical testing laboratory. Must have very pleasing personality to meet clients. Salary, $3000–$5000 a year. New Jersey. Y-9703.

MAINTENANCE ENGINEER, 30–40, with extensive experience in warehousing and material handling and qualified to make building alterations, design and lay out mechanical-handling equipment, and install order handling procedure. Mercantile organization operating 14 warehouses for distribution of merchandise to retail stores. Salary, $5000–$7500 a year. New York, N. Y. Y-9728.

MECHANICAL ENGINEERS (or electrical engineers if with proper experience) with considerable experience in production-engineering work in a metal-manufacturing or allied line. Pennsylvania. Y-9732.

ENGINEERS. (a) Mechanical engineer, 30–40, production experience with heavy equipment; metals, heavy ordnance; also (b) Mechanical engineer, preferably with some engineering training, and some knowledge of production, and statistical experience suitable for production analysis. Salaries, $5600–$6500 a year. South. Y-9736.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after February 25, 1942, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

For Member, Associate, or Junior

NEW APPLICATIONS

ADLER, FRANK R., Hermosa Beach, Calif.
AMES, CHARLES S., JR., Washington, D. C.
BAKER, JACK M., South Charleston, W. Va.
BARTON, MILLAR V., College Park, Md.
BIRN, SERGE A., Chicago, Ill.
BROWNLIE, WM. N., Boston, Mass.
CLEARY, JAS. W., Parlin, N. J.
DREWELOW, EARL J., Riverton, Kans.
DUNHAM, ELMER J., Battle Creek, Mich.
FLINT, AMOS H., Chicago, Ill.
GOEBEL, RUDOLPH C., St. Paul, Minn.
GOVE, NORRIS D., Prospect Park, Pa.
GROSSWENDT, CARL T., New York, N. Y.
HADLEY, FREDK. V., Boston, Mass. (Rt)
HEARD, M. EARL, Philadelphia, Pa.
HUGHES, ELMER C., Sandusky, Ohio
JAMES, H. M., Monroe, La.
JOHNSON, OWEN C., Los Angeles, Calif.
JONES, HENRY S., Wyoming, Ohio
LOGUS, ANTHONY T., Chicago, Ill.
LUDWICK, WM. L., East Orange, N. J.
LUNDQUIST, GEO. T., San Francisco, Calif.
LUNDSTROM, ERNEST A., Wellsville, N. Y.
MACGOWAN, GEO. F., Flushing, L. I.
MANUELE, JOS., East Pittsburgh, Pa.
NEWLOVE, BENJ. C., Los Angeles, Calif.
MARSHALL, CARL A., Bronxville, N. Y. (Rt & T)
MCKENZIE, JAS., Toronto, Ont., Can.
MOTCH, EDWIN R., Cleveland, Ohio
NYSTROM, KARL T., Hammond, Ind.
OWSLEY, WM. D., Duncan, Okla.
PICKENER, ELMORE, Newton Upper Falls, Mass.
RHODES, AUGUSTUS L., New Rochelle, N. Y.
SHERFEY, HESTER F., Hopewell, Va.
TOMPKINS, FRANCIS M., Washington, D. C.
WALLACE, WM. L., Philadelphia, Pa.

CHANGE OF GRADINGS

Transfer to Fellow

WOHLENBERG, WALTER J., New Haven, Conn.

Transfer to Member

DAVIDSON, JESSE I., Flushing, L. I., N. Y.
KERR, HENRY K., Peterborough, Ont., Canada
LOVE, CLYDE P., Chile, S. A.
MARSHALL, JAY C., Oak Park, Ill.
WILDER, CECIL L., Binghamton, N. Y.

Necrology

THE deaths of the following members have recently been reported to headquarters:

ALFORD, LEON P., January 2, 1942
ALLIEVI, LORENZO, October 30, 1941
AVIS, SAMUEL W., December 17, 1941
BERG, HART O., December 9, 1941
CARPENTER, HUBERT V., November 15, 1941
CLARK, FRANK C., October 28, 1941
DICKEY, DONALD E., November 28, 1941
ELLIOTT, ROBERT B., November 3, 1941
FRICKER, JACOB E., December 20, 1941
GRAF, ANDREW J., December 3, 1941
KELLER, GEORGE J., August 29, 1941
MADLEM, D. W., August 5, 1941
MARKLAND, GEORGE L., JR., August 14, 1941
MARZOLF, JOSEPH M., December 13, 1941
MILLS, BERNARD, August 18, 1941
SEE, A. B., December 16, 1941
SHAW, EDWIN C., November 26, 1941

A.S.M.E. Transactions for January, 1942

THE January, 1942, issue of the Transactions of the A.S.M.E., contains:

Modern Steam Passenger Locomotives—Research and Design, by P. W. Kiefer
Francis-Turbine Installations of the Norris and Hiwassee Projects, by G. R. Rich and J. F. Roberts
The Separation of Liquid From Vapor, Using Cyclones, by Arthur Pollak and L. T. Work
Analyzing Governor-System Performance, by A. F. Schwendner
Silica Removal by an Improved Magnesia Process, by H. L. Tiger